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MONTANA DEPARTMENT OF STATE LANDS
U.S. OFFICE OF SURFACE MINING

DRAFT
ENVIRONMENTAL IMPACT STATEMENT

WESTERN ENERGY COMPANY'S ROSEBUD MINE AREA C, BLOCK 1

Prepared by
Montana Department of State Lands
U.S. Office of Surface Mining

James Harris, Director
U.S. Office of Surface Mining

Gareth Moon, Commissioner
Montana Department of State Lands

MAY, 1982

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United States Department of the Interior
OFFICE OF SURFACE MINING
Reclamation and Enforcement
BROOKS TOWERS
1020 15TH STREET
DENVER, COLORADO 80202

June 7, 1982

To Whom It May Concern:

Below are errata for the Rosebud Area C, Block I draft environmental impact statement. Several errors were found in Table III-3, which you may wish to correct in your copy. We regret any inconvenience this may have caused.

Sincerely,

Richard Dawes
Deputy Administrator
Western Technical Center

ERRATA

1. Delete Page III-10a.
2. Correct Table III-3. Corrected values are underlined.

TABLE III-3
GROUNDWATER DISCHARGE
MINING IMPACTS TO SURFACE DRAINAGES
(1983 and 1987)
ROSEBUD MINE AREA, MONTANA

Drainage Area	Discharge (in cubic feet per day) 1983	1987	% change
Coal Bank Coulee	1,533	1,537	+0.003
East Fork Armells Creek	20,611	30,214	+47.000
Hay Coulee	4,570	4,595	+0.001
Lee Coulee	7,579	7,593	+0.002
Miller Coulee	4,575	4,581	+0.001
Cow Creek	14,500	14,500	0
Pony Creek	8,500	8,500	0
Richard Coulee	10,603	10,603	0
Rosebud Creek	33,205	33,206	0
South Fork Cow Creek	1,239	1,239	0
Stocker Creek	21,826	21,693	-0.006
Unnamed Coulee	3,739	3,739	0

SUMMARY

(x) Draft ( ) Final Environmental Impact Statement

Montana Department of State Lands
U.S. Office of Surface Mining

Type of Action: (x) Administrative ( ) Legislative

Western Energy Company proposes to begin mining in Sections 1, 2, 3, and 11 in T1N, R40E, and has submitted a mine permit application for this proposed action. The Commissioner of State Lands and the Secretary of Interior must decide whether to 1) approve the permit as proposed; 2) approve the permit with stipulations; or 3) deny the permit or portions of the permit.

Brief Description of the Company's Proposal:

Western Energy proposes to remove an estimated 24 million tons of coal from an area of 709 acres over a period of five years. An additional 1,145 acres would be used for shop facilities, haul roads, topsoil stockpiles, boxcut and highwall reduction areas, a crusher facility, and the coal conveyor. The mine plan permit area would total 3,104 acres, 1,227 of which would not be disturbed. Coal would be transported to Colstrip Units 3 and 4 for power generation via a coal conveyor.

Mining is anticipated to begin in 1983 and proceed until 1988, and active reclamation of the area in question will continue until at least 1991.

Western Energy has not submitted to OSM or DSL a complete life of mine proposal for Area C, although the company would probably implement a 34-year mine plan during Block I mining. Over the entire Area C life of mine, approximately 5,040 acres would be mined and an additional 1,525 acres disturbed by related activities.

Summary of Impacts by Discipline:

- Geology - geologic impacts would be minor, including disruption of the stratigraphy by removal of the Rosebud coal and replacement with spoil material, general smoothing and a slight lowering of the topography, possibe creation of gullying and slumping along the highwall/backfill interface and to a lesser extent in other areas in the reclaimed spoils, a slight decrease in electrical conductivity in the near-surface material, and potential localized increases in molybdenum, nickel, or cadmium in near-surface layers.

- Hydrology - groundwater aquifers would be distrupted by mining and replaced with spoils that would have similar flow characteristics to the original aquifers. Groundwater flow would be intercepted by the pit during mining. The majority of groundwater discharge

to the pit would occur immediately after the pit is opened and would diminish with time. The water levels in the spoils would eventually reach pre-mining levels.

The concentration of total dissolved solids in the spoils aquifer would be approximately twice that of the present Rosebud coal and overburden aquifers. Spoils water would follow the regional southeast flow direction and would eventually reach Cow Creek. The quality of water in aquifers underlying the Rosebud coal would generally not be affected by the placement of spoils. Water discharging at the boundaries of the mined area to streams would have no appreciable effect upon surface water quality. However, water discharging from the spoils to the valley fill of East Fork Armells Creek would displace water in the valley fill and would increase concentrations of total dissolved solids.

The probable impacts to the surface water hydrology would include a decrease in the total volume of runoff from the mined areas, a reduction of peak flow magnitudes, and the near-total removal of sediment introduced to the streams from the mined areas, all due to the placement of sediment ponds. Sediment ponds may also cause an episode of high erosion upon removal. An indirect impact of mining may result from an increased population in Colstrip and additional power facilities in the form of increased water discharges to East Fork Armells Creek due to municipal water use and seepage from ponds. This impact may have detrimental consequences downstream of the pond.

- Climate - mining in Area C would have no impact on the climatic regime in the area.

- Air quality - a slight increase in fugitive dust would occur in the locality of the mine. Projected levels would be far below federal and state air quality standards and would represent a minor impact. Impacts to the townsite of Colstrip and to the Class I area (the Northern Cheyenne Indian Reservation) would be below detection limits.

- Noise - increased noise levels due to construction, operation of mining equipment, or blasting would be audible only near the site and would not influence the noise levels presently occurring in Colstrip.

- Soils - soils of the area would experience mixing and some alteration of chemical and physical properties. These changes would influence the post-mining potential for crop production and might limit the successful establishment of conifers or warm-season grasses. Organic matter of the soils would decrease, bulk densities might increase, and nutrient cycling in the soil would take a number of years to reach equilibrium.

- Vegetation - impacts to vegetation would include a temporary disruption of vegetative cover and reestablishment of vegetation

dominated by productive cool-season grasses and legumes. Most crop and pasture areas would be replaced with native grasses and legumes. Forage production would increase with an accordant increase in the grazing capacity over pre-mine levels, but may not equal the potential forage productivity that could be achieved on the existing range sites. There would be a likely decrease in warm-season grasses when compared to pre-mine conditions and a significant decrease in the potential for warm-season grasses on the post-mined soils. Shrub cover would decrease and there would be fewer areas of ponderosa pine in the post-mined areas.

- Wildlife - several wildlife habitats would be temporarily destroyed by the project, and a long-term reduction in ponderosa pine stands and shrub habitats and their associated wildlife would result in the mined area. Sharp-tailed grouse dancing grounds may be substantially disturbed. An inactive golden eagle nest may experience some secondary impacts due to nearby mining activities. Continuation of mining through the remainder of Area C would destroy an eagle's nest and two sharp-tailed grouse dancing grounds.

- Sociology and economics - population increases contributed by the project would be greatest in the second quarter of 1983, and would postpone but not prevent the decline in population due to completion of Colstrip power generating Units 3 and 4. Social impacts would be small due to the similarity of existing and incoming work forces and is not expected to significantly affect the level of services required. An 11 percent increase in revenues or expenditures could be expected for any given year.

- Land use - the mine and associated disturbances would displace 606 acres of cropland, of which all but 60 acres would be reclaimed to rangeland following mining. Temporary displacement of grazing would occur over much of the area to be mined, to be restored in some reclaimed areas prior to bond release and in the entire area after mining is completed.

- Transportation - four miles of East Fork Castle Rock Road would be permanently relocated. Current daily traffic volumes would increase by less than five percent during both construction and operation phases of the mine.

- Recreation - recreation resources in Colstrip and Rosebud County are presently insufficient to serve the existing population. The project would serve to prolong the period of high population, thus extending these use pressures; however, the anticipated decline in Colstrip's population by 1985 or 1986 due to completion of Units 3 and 4 and winding down of Area C construction would reduce all of the project-related population increases.

- Cultural resources - Nine cultural resource sites are located within Area C, Block 1, and 25 are located within a one-mile buffer zone around Area C, Block 1. Three cultural resources

sites that have been identified as potentially eligible for nomination to the National Register of Historic Sites would be partially or totally destroyed and one site, also potentially eligible for nomination, could be directly impacted by the project. Five sites with the same potential status may be indirectly impacted by blasting or other activities. Testing or additional information is required for five sites before their significance as cultural resources can be assessed. The remaining 20 sites within Area C, Block 1 and the buffer zone do not appear eligible for National Register nomination. Of these 20 sites, three would be destroyed, one could be directly impacted, and 16 could be indirectly impacted. Areas proposed for mining outside of Block 1 would be surveyed and mitigation requirements met in accoradance with the National Historic Preservation Act prior to permitting.

- Aesthetics - the landscape would experience an alteration in color, contrast, and texture due to the reduction or loss of ponderosa pine, shrub areas, and sandstone outcrops, none of which are intrinsically unusual for the region.

Relationship between short-term uses of the environment and long-term productivity:

The 166 million tons of coal mined from Area C would serve as the sole source of fuel to be burned in Colstrip generating Units 3 and 4. This short-term use of the Block I mine site would last through 1988, when mining in Area C, Block I would end, and through 2017 for all of Area C when the economically recoverable coal would be exhausted. If the mine area were not disturbed, it would continue to produce winter wheat, livestock forage, wildlife habitat, and limited scenery. Crop production, wildlife habitat, and scenic value will be reduced after reclamation. Compared to the pre-mining (1978) conditions, productivity for livestock grazing would increase, however the potential productivity of the post-mined area would be lower than the pre-mining potential, primarily due to the loss of discrete sandy soil areas.

Irreversible and irretrievable commitments of resources:

Under the Block I proposed mine plan, the mine would produce 23.7 million tons of coal from the Rosebud seam and leave 9.6 million tons of the lower quality McKay coal seam, for which no current market exists. Future mining would be unlikely if a market became available, due to very high overburden thickness. For the entire Area C life of mine, about 166 million tons of coal would be recoverdd from the Rosebud seam. About 66 million tons of coal would be left in the McKay seam. The McKay seam would probably not be mined in the future.

If federal leases become available adjacent to the Block I area, overburden averaging might allow recovery of additional coal that is considered unminable under the proposed Block I mine plan. If this option becomes available after the mining of Block I, a significant amount of coal in these areas would be unavailable for future mining.

The existing stratigraphy would be permanently altered, however, the stratigraphy is not unusual or intrinsically valuable. The existing topography would be altered, and mixing of stratigraphy and overburden would alter the character and land use potential of the reclaimed surface. The likelihood of establishing a vigorous productive vegetative cover is excellent, however vegetative diversity and successful establishment of conifers or certain shrubs may be limited after mining.

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CHAPTER I

DESCRIPTION OF THE PROPOSAL UNDER CONSIDERATION

A. SCOPE OF THE ANALYSIS

Western Energy Company (Western Energy) has applied to the Montana Department of State Lands (DSL) and the Office of Surface Mining (OSM) for a surface mine permit for Area C, Block I of its Rosebud Mine near Colstrip, Montana (Figure I-1). The company proposes to permit a five-year mine area encompassing 2,693 acres referred to as Block I, as shown in Figure I-2. The sequence of mining proposed for Block I is depicted in Figure I-3.

Under the provisions of the Montana Strip and Underground Mine Reclamation Act, DSL must approve the mining and reclamation plan (hereafter called the "mine plan") for the proposed Block I mine area before mining or related facility construction can begin. Federal approval to begin mining must be obtained from the U.S. Department of the Interior, Office of Surface Mining (OSM). In addition, the federal coal lease in Section 2 T1N, R40E will have to be renewed in August of 1986.

The Block I mine plan was submitted by Western Energy as a complete life of mine plan, scheduled to be terminated with complete reclamation of the proposed five-year mining area. This mining plan was developed and submitted because the company did not have federal coal leases in Sections 4 and 10, T1N, R40E or Section 12, T1N, R41E. Without these key leases, continuous mining directly from Block I through the remaining 5,300 acreas of Area C would not be economically feasible.

On April 28, 1982 the Bureau of Land Management held a coal lease sale at which Western Energy submitted the apparent high bid for these and other parcels. The issuance of leases usually follows a sale by several months. This sale has been challenged and may delay or prevent issuing the leases. Nevertheless, it appears reasonable to assume that the company may eventually obtain these leases and implement the 34-year life of mine plan for Area C, known as Block II.

The Block II mine plan would begin in the proposed Block I permit area during the second year if the company obtains the leases prior to completing the third mining cut. A comparison of Figures I-3 and IV-1 will illustrate the reorientation of the mining pits required to initiate the Block II plan.

The pit realignment and its environmental effects within the proposed Block I mine area are discussed in Chapter IV, Section B.

This EIS is designed to serve as an informational and environmental document for the OSM, DSL, and the general public, in compliance with the National Environmental Policy Act (NEPA) and the Montana Environmental Policy Act (MEPA). Technical Support Documents for this EIS are available for public review at several locations (listed in Chapter V) throughout the state. Prior to approval of the surface mining permit

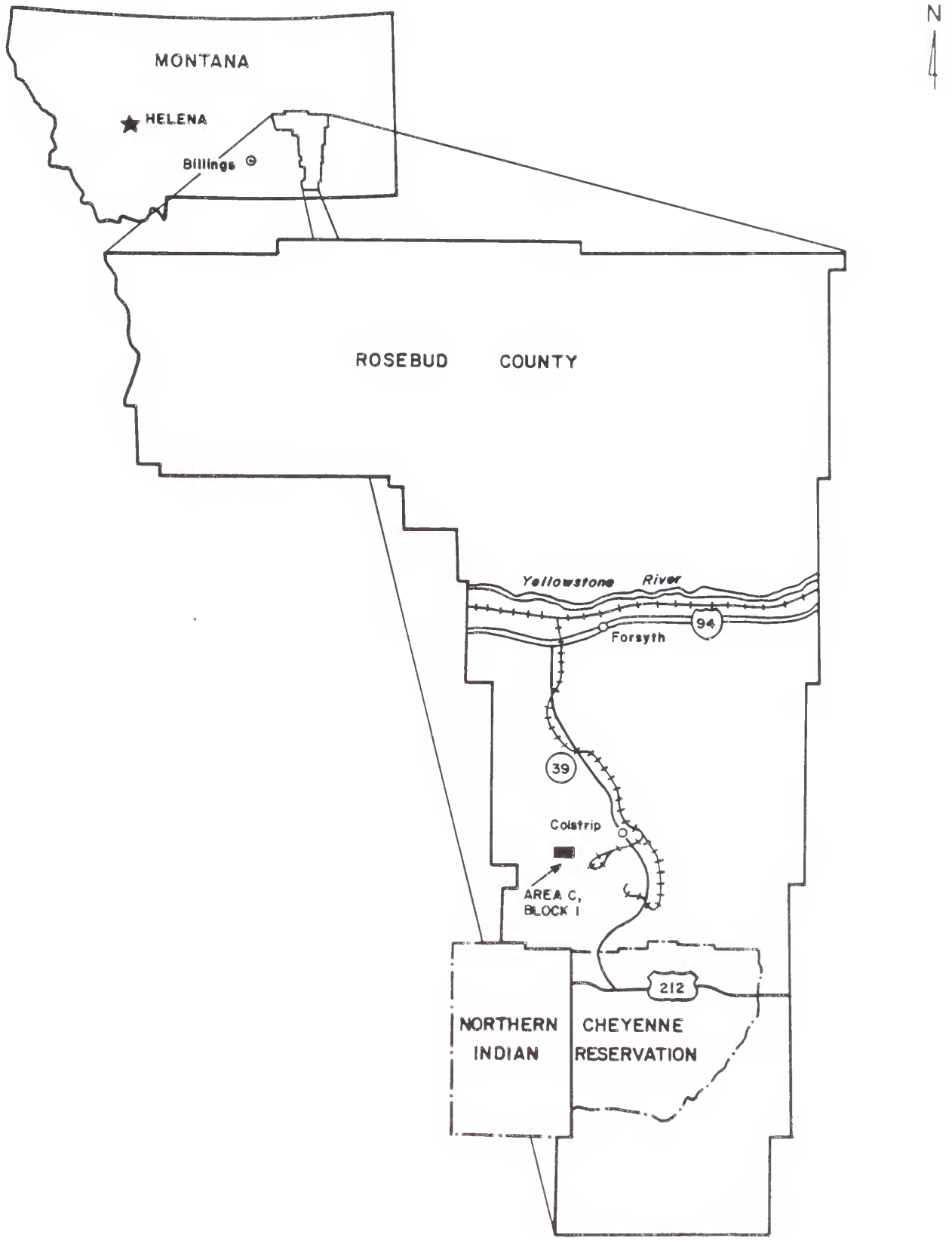


FIGURE I-1 LOCATION OF AREA C, BLOCK I

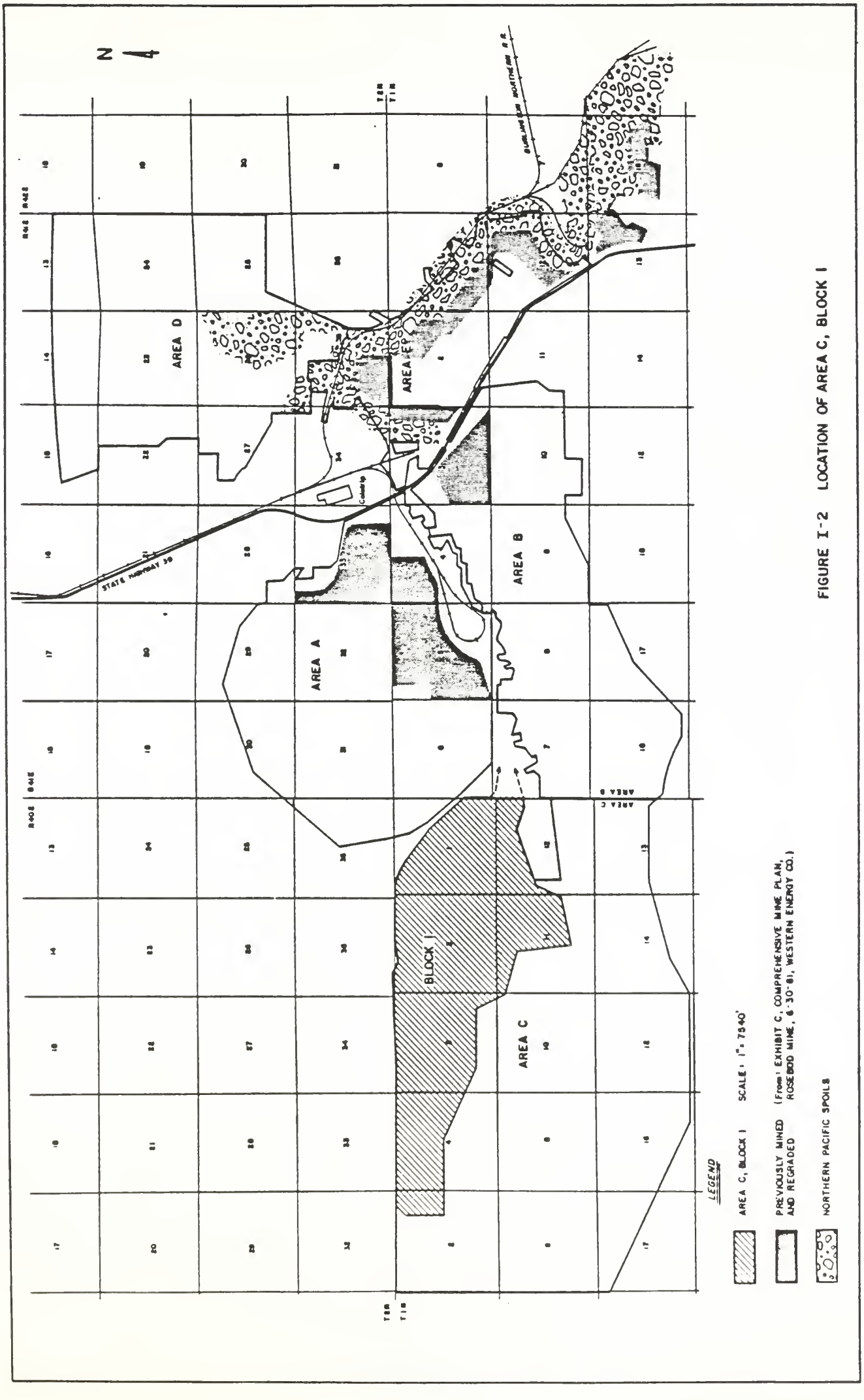


FIGURE I-2 LOCATION OF AREA C, BLOCK I

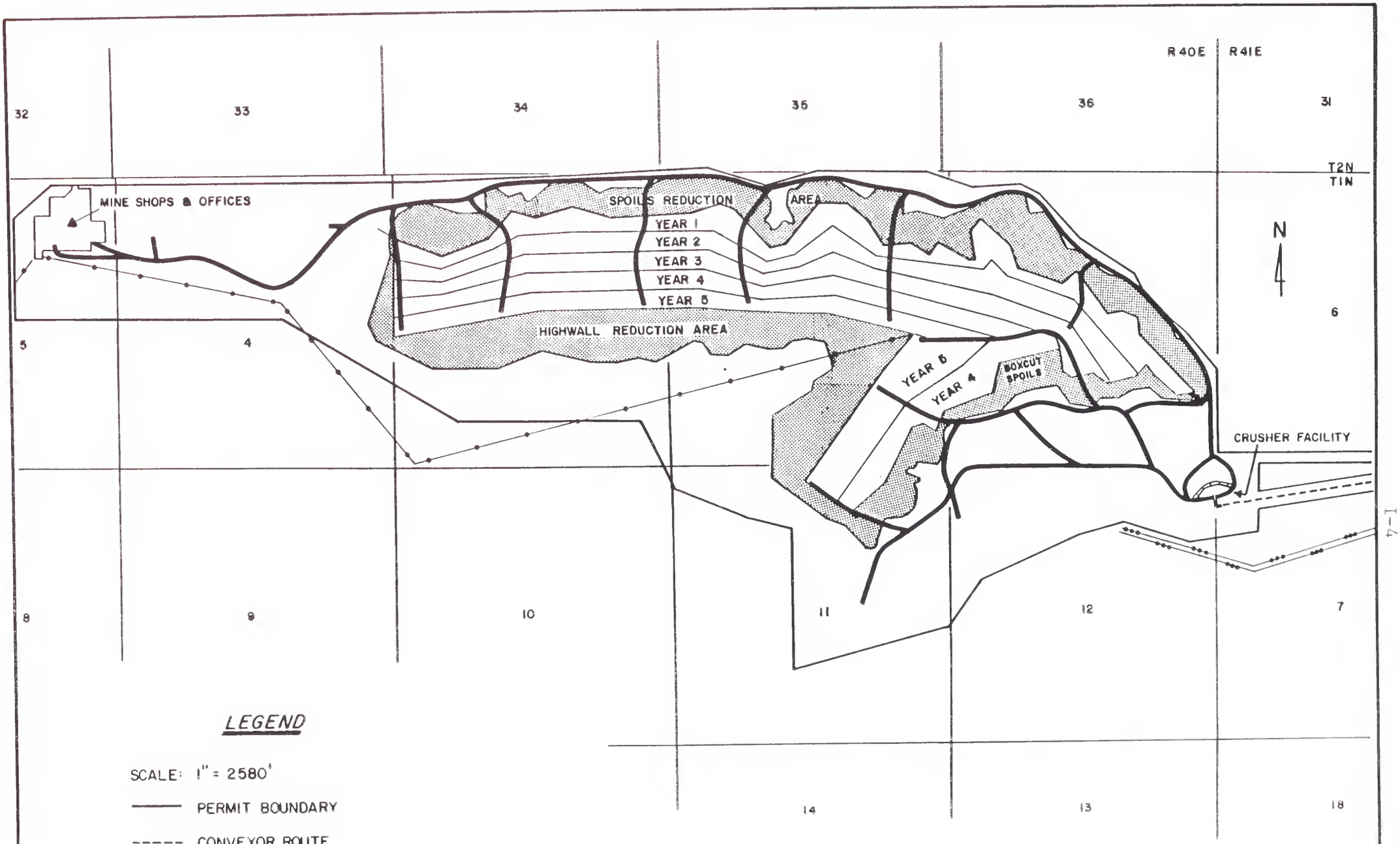


FIGURE I-3 SEQUENCE OF MINING AT AREA C, BLOCK I

application, a findings of compliance with the federal and state surface mining statutes must be made by the regulatory agencies (OSM and DSL). Approval of the permit is a process separate from the EIS.

Only two other permits are required to conduct the proposed surface mining operations, aside from the surface mining permit: an air quality permit and a water pollutant discharge permit, both of which are issued by the Montana Department of Health and Environmental Sciences (DHES). The DSL has entered into a Memorandum of Understanding with the Department of Health and Environmental Sciences stating that the Area C, Block I EIS will satisfy the Air Quality Bureau's MEPA needs regarding the issuance of an Air Quality Permit.

Western Energy has applied to the DHES to amend the existing air quality permit for the Rosebud Mine (Permit #1483) to include the proposed activities at Area C, Block I. Western Energy will also be applying for a water pollutant discharge permit from DHES. Although DSL does not issue air and water quality permits, the agency can require measures to control fugitive dust and water pollution from mined lands and reclaimed areas.

Previous EISs have been prepared for mining and mining-related projects in and adjacent to the Rosebud Mine, and have been used in the preparation of this document. Among these are the Northern Powder River Basin EIS (U.S. Department of Interior, 1979), the Colstrip Project EIS (U.S. Department of Interior, 1979), the Rosebud Mine Area B Extension EIS (MDSL, 1980), and the Rosebud Mine Area E Extension EIS (MDSL, 1981). The Colstrip Project EIS (1979) specifically addresses the potential impacts of mining in Areas C and D of the Rosebud Mine.

Presently, in addition to this site-specific EIS, a comprehensive EIS is being prepared to evaluate the impact of mining at the Rosebud Mine for the life of the mine, through the year 2017. The comprehensive EIS will address the cumulative impact of all proposed mining activities at the Rosebud Mine in relationship to all other mining and industrial activities in the area around the Rosebud Mine (Figure I-4). Several EISs for other projects in the Rosebud County area are currently in progress or proposed, including Western Energy's Area B and Area E EISs and MONTCO's EIS. The impact from these proposed mine areas, the Big Sky Mine, and other projects for which no EISs are available were considered during the preparation of this EIS. The locations of other active mines close to the Rosebud Mine are depicted in Figure I-4.

B. MINE HISTORY

Surface strip mining of the coal resource was begun in the Colstrip area by Northern Pacific Railroad. During the period from 1924 to 1958, Northern Pacific extracted approximately 44 million tons of coal from the Rosebud seam to be used for steam locomotives and domestic purposes, resulting in approximately 1,800 acres of surface disturbance.

When the Northern Pacific Railroad changed from steam locomotives to diesel locomotives, mining ceased. In 1959, the mining leases and the townsite of Colstrip were purchased by Montana Power Company (MPC). In

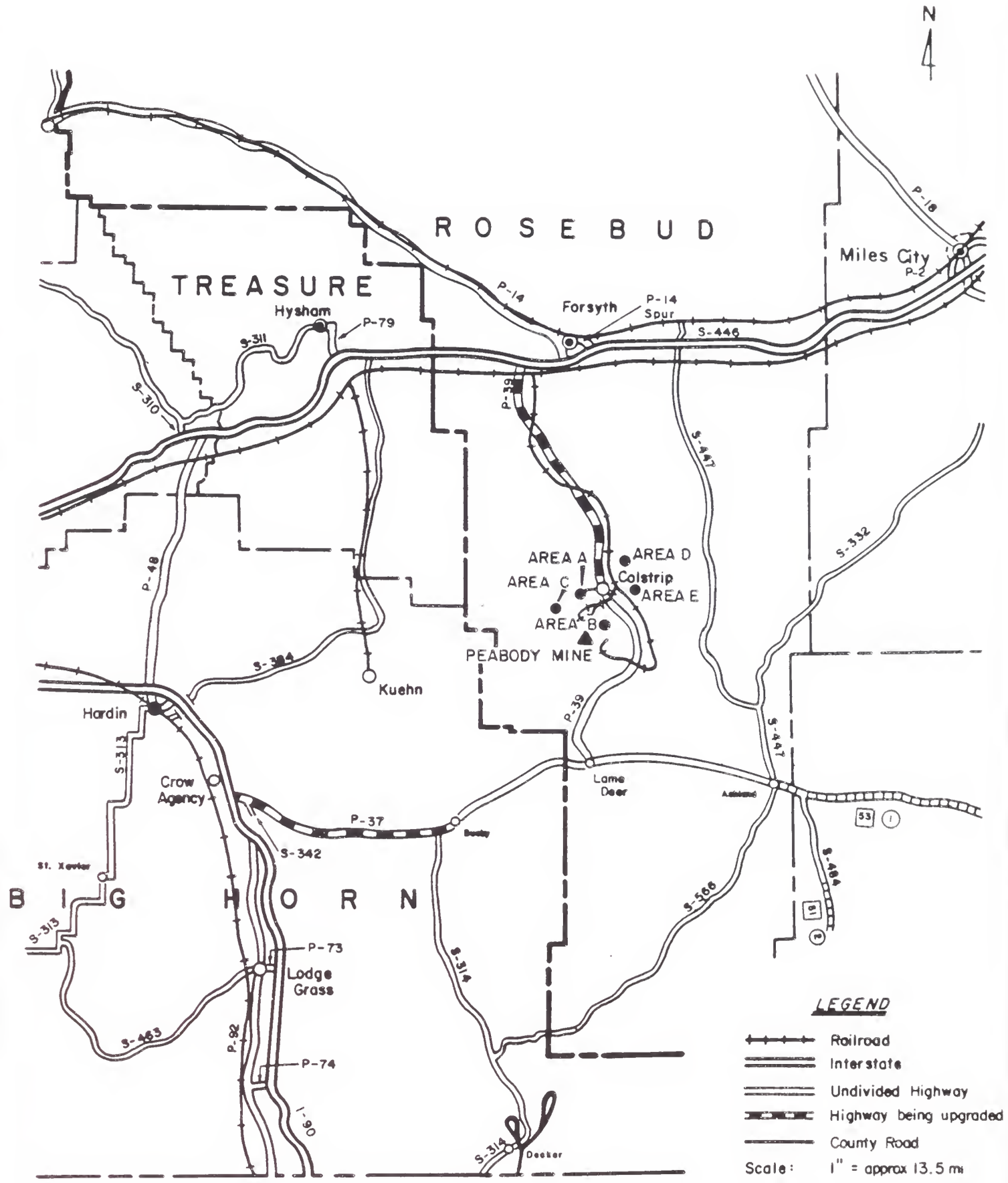


FIGURE I-4 LOCATION OF PEABODY MINE IN RELATION TO THE ROSEBUD MINE AREA

1966, Western Energy, a wholly owned subsidiary of MPC, was formed to manage and develop the properties. In 1968, Western Energy began mining the coal of the Rosebud seam adjacent to Northern Pacific's old workings in an area called Pit 6. Western Energy has subsequently completed mining in Pit 6, and has expanded mining of the Rosebud seam in Areas A, B, and E. Numerous permits have been granted and numerous EISs written related to mining in these areas. Copies of each permit application and EIS are on file with DSL in Helena, Montana.

Table I-1 shows the approximate projected annual coal production by year from Area C, Block I during the period from 1983 through 1988 and the approximate annual production in five year increments for the remainder of Area C.

C. WESTERN ENERGY COMPANY'S PROPOSAL

1. Summary

Western Energy's proposed Area C, Block I mine is in southwestern Rosebud County, Montana, about five miles west of the town of Colstrip (Figure I-4). Coal would be transported by conveyor from the mine to MPC's Colstrip power generating facility, Units 3 and 4, a distance of about four miles, and would become the sole source of fuel for these units.

Coal production from Area C, Block I would average 4.7 million tons of coal per year over the five-year mining period, ranging from 3.8 million tons for the first year to 5.6 million tons for the fifth year. These reserves would be mined through the year 1988 at an average annual rate of 4.7 million tons per year. The probable life of mining activities in Area C is expected to be at least 34 years, with the anticipation that successive five-year mine blocks would be permitted sequentially after Block I.

Of the six coal seams underlying the proposed mining area, only the uppermost two, the Rosebud and the underlying McKay, are of economic importance. Western Energy mines only the Rosebud seam, because a market has not been found for the McKay coal, which has a higher sulfur content than the Rosebud coal and has a tendency to form slag in some steam boilers.

The land surface in Area C, Block I is owned by Burlington Northern, Inc. and Farley's, Inc. The coal to be mined is leased by Western Energy from Burlington Northern and the federal government. Surface ownership and coal leases for Area C are shown in Figures I-5 and I-6, respectively.

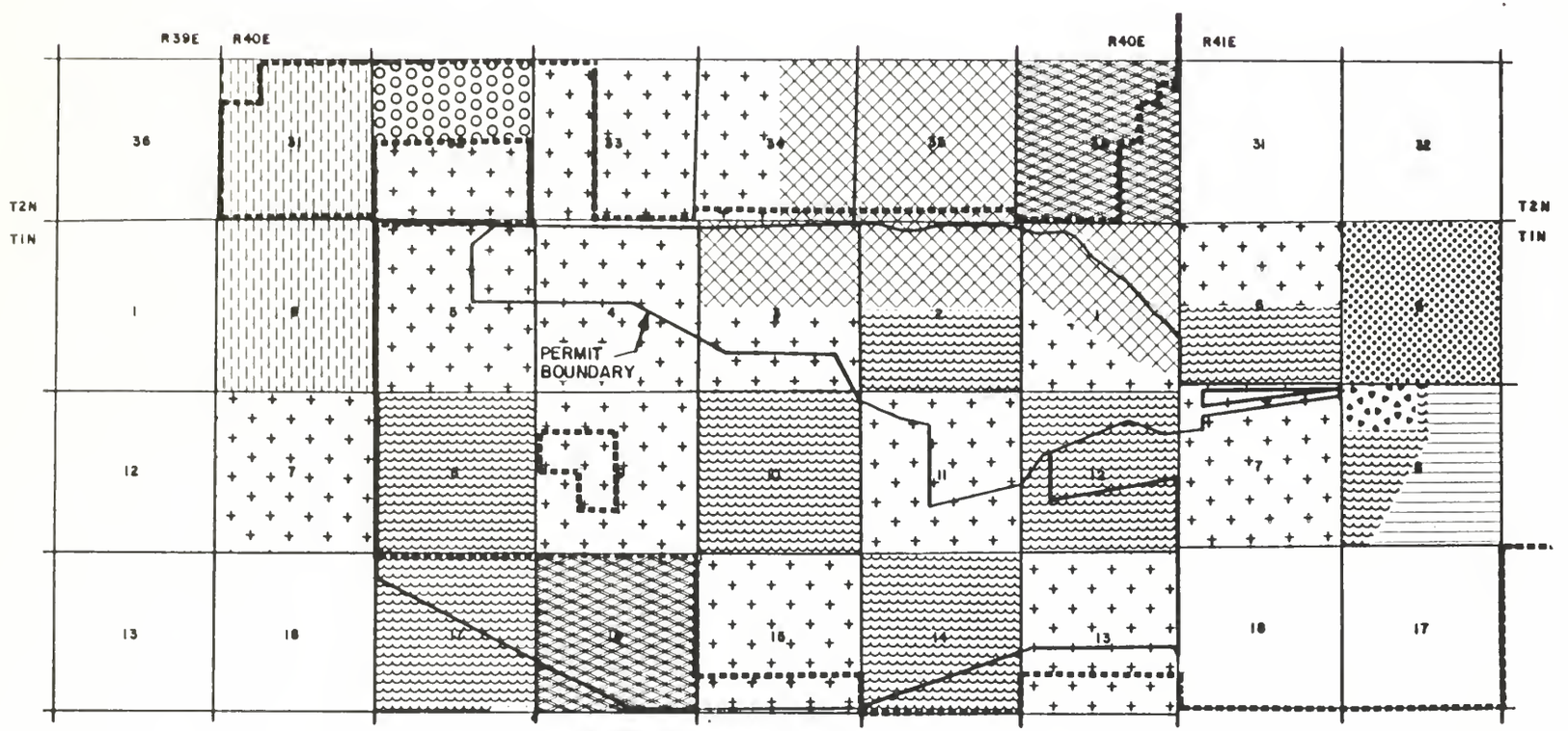
The increased labor force required for early construction phases would be approximately 300 to 400 people, with a net increase of approximately 200 people to operate the mine and support facilities.

TABLE I-1

APPROXIMATE ANNUAL PRODUCTION BY YEAR

Year		Five Year Plan Production (Million Tons)
1	9/83-8/84	3.8
2	9/84-8/85	4.0
3	9/85-8/86	4.8
4	9/86-8/87	5.5
5	9/87-8/88	5.6
		23.7

Years	Life of Mine-Area C Tons (Million)
1 - 5	24
6 - 10	28
11 - 15	25
16 - 20	23
21 - 25	23
26 - 30	23
31 - 34	20
	166



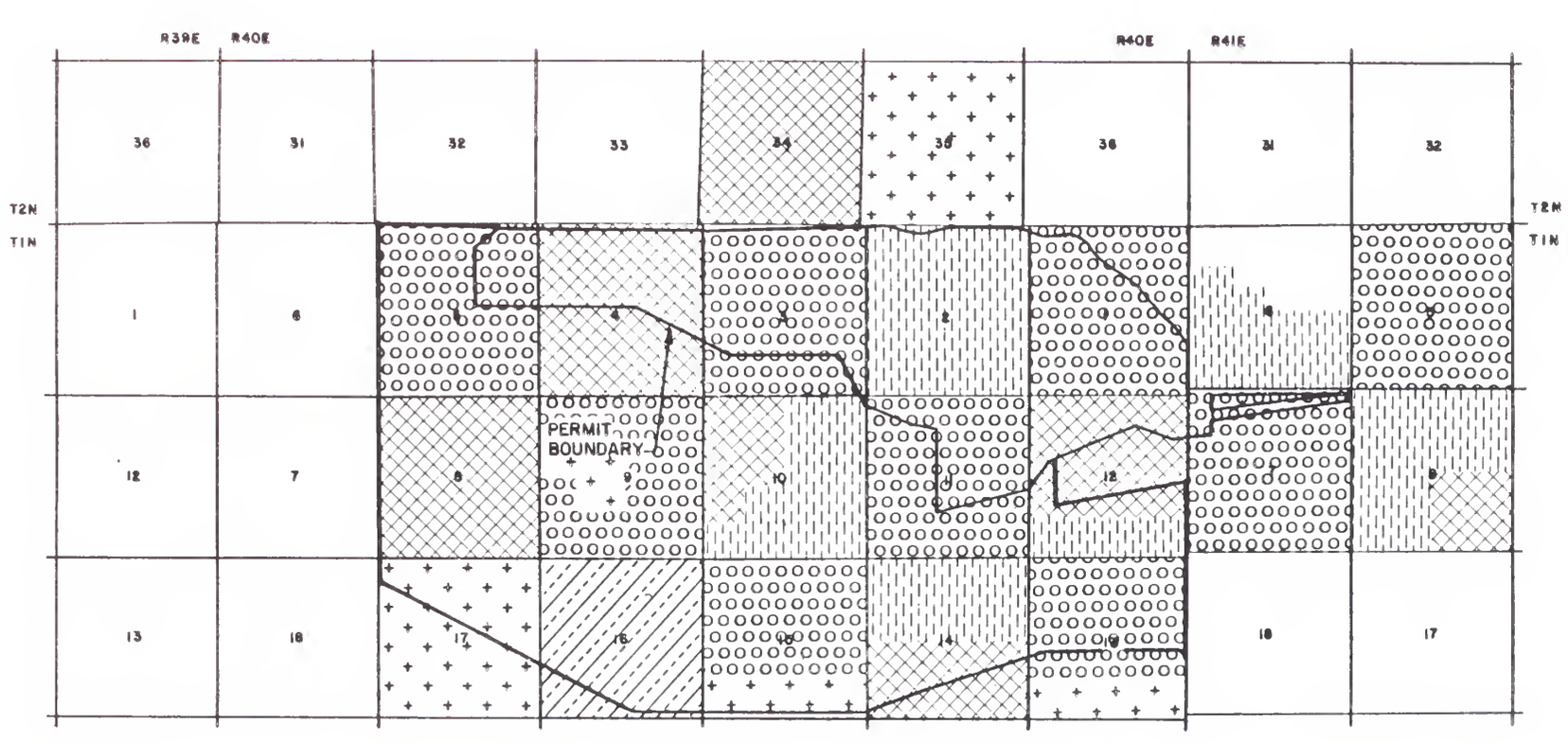
LEGEND

- AREA OF WESTERN ENERGY SURFACE AGREEMENTS
- BURLINGTON NORTHERN LEASED TO FARLEY'S INC.
- WESTERN ENERGY LEASED TO FARLEY'S INC.
- BURLINGTON NORTHERN LEASED TO HUGH BROADUS
- BURLINGTON NORTHERN LEASED TO DON SNIDER
- WESTERN ENERGY LEASED TO G. ASHENHURST
- STATE OF MONTANA
- WESTERN ENERGY LEASED TO GREENLEAF LAND & LIVESTOCK
- BURLINGTON NORTHERN UNLEASED
- FARLEY'S INC.

PERMIT BOUNDARY

SCALE: 1" = 6450'

FIGURE I-5 -- SURFACE OWNERSHIP AT AREA C, BLOCK I



LEGEND

- U.S. LEASED TO WESTERN ENERGY (COAL LEASE MONTANA 073109)
- BURLINGTON NORTHERN LEASED TO WESTERN ENERGY (T & M CONTRACT NO. 3982)
- U S NOT LEASED
- BURLINGTON NORTHERN NOT LEASED
- PERMIT BOUNDARY
- STATE OF MONTANA

SCALE 1" = 6450'

FIGURE I-6 -- COAL LEASES AT AREA C, BLOCK I

2. Facilities

Western Energy plans to construct two separate facility complexes to support the Area C, Block I mine operation: (1) a shop and office facility; and (2) a coal crusher and conveyor facility, with an associated overland conveyor corridor beginning at the crusher facility and extending a distance of four miles to MPC's electric generation Units 3 and 4 (Figure I-7). All but one mile of the conveyor system will pass through areas presently permitted to Western Energy in Areas A and E. Facility construction is scheduled to begin in June of 1982 and will be completed by July of 1983.

The new shop and office facilities will include:

- An office building
- A parts warehouse, with adjoining storage yard
- A lubricant storage building, with adjoining fuel storage tanks
- An equipment repair building
- A machining and welding building
- A crew change building, with adjoining parking lot
- A sewage treatment facility
- Adjacent parking facilities

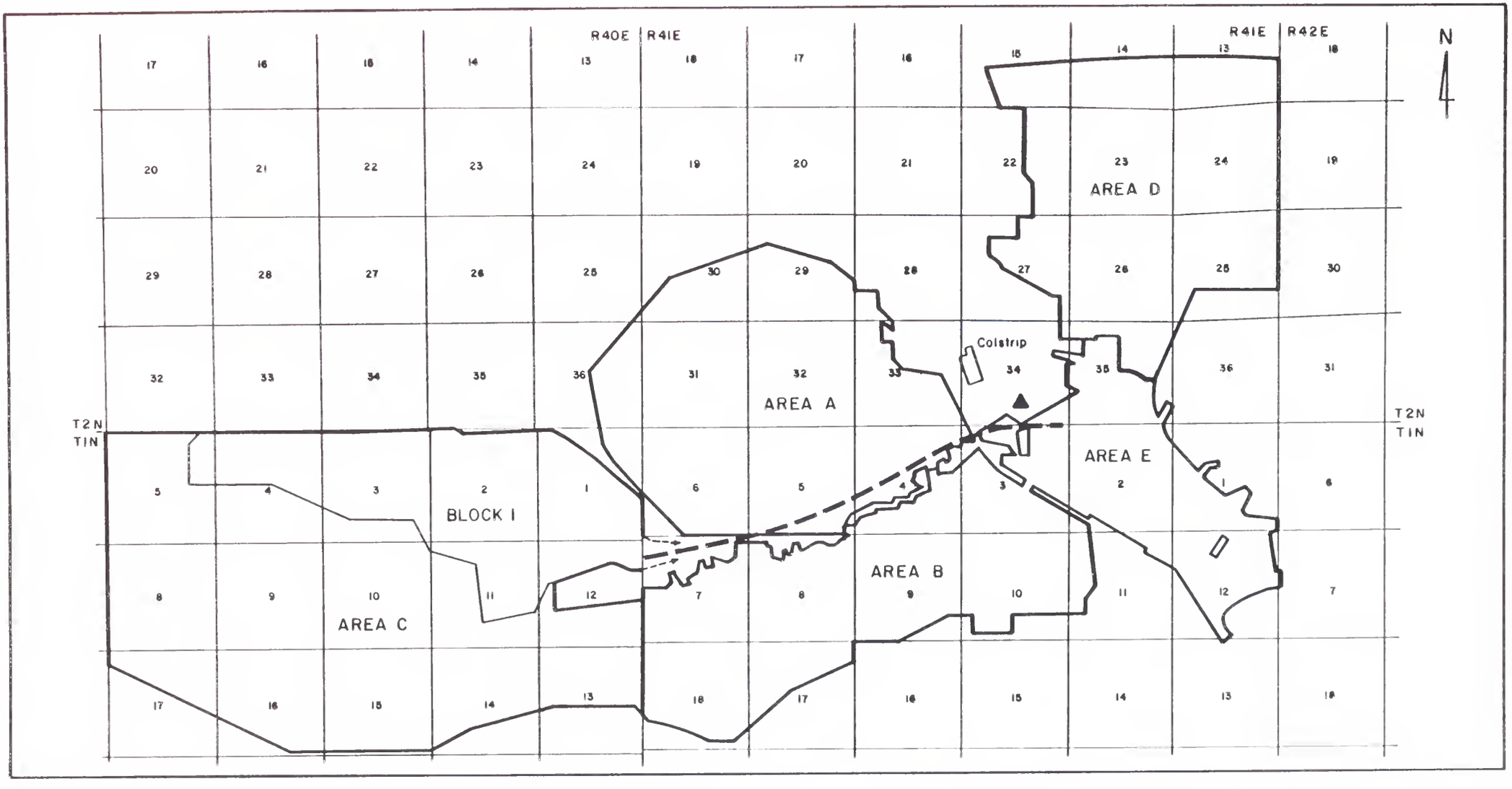
Facilities to be included in the new crusher complex are:

- Fuel storage tanks
- Negative air pressure truck dump
- Primary crusher
- Secondary crusher
- Beginning of an overland conveyor

3. Mining Plan

Western Energy's mine plan is a five-year plan to conduct surface mining operations in Area C, Block I of the Rosebud Mine. Block I is located in Sections 1, 2, 3, 4, 5, 11, and 12 of T1N, R40E and Section 7 of T1N, R41E. The permit area addressed in the mine permit application encompasses 2,693 acres, of which 709 acres are proposed to be mined, and an additional 918 acres are planned to be disturbed as a result of mining-related activities, including a shop complex, crusher complex, haul roads, topsoil storage areas, boxcut, and highwall reduction areas. Approximately 1,066 acres within the permit area will remain undisturbed under this mine plan. Additionally, the conveyor corridor would occupy about 226 acres, running 4.5 miles from the Area C, Block I mining area to Colstrip power generating Units 3 and 4.

It is planned that a total of 23.7 million tons of coal from the Rosebud seam will be mined from Area C, Block I as a dedicated fuel source for Colstrip Units 3 and 4. Western Energy has proposed a typical single pass dragline operation as the optimum method for coal recovery. Extraction of the reserves lying within this mine plan area will be



LEGEND

CONVEYOR ROUTE

LOCATION OF MPC GENERATING UNITS

SCALE: 1" = 7540'

FIGURE I-7 CONVEYOR ROUTE, ROSEBUD MINE, MONTANA

accomplished by the area strip mining method, which is used in all of Western Energy's operations at Rosebud Mine. The maximum production rate will be approximately 5.6 million tons of Rosebud coal per year, which will be attained during the fourth and fifth years of production.

The mine plan calls for developing a boxcut with a dragline along the coal outcrop line (see Year 1 in Figure I-3). The overburden from the boxcut (or first cut) would be placed on an area outside the coal outcrop line directly adjacent to the boxcut. Successive pits would parallel the boxcut, progressing into deeper overburden to the south and northwest through Year 5 as shown in Figure I-3. Overburden from each successive dragline cut would be placed in the previous pit after removal of the coal. As new federal leases become available to Western Energy in Area C, it is intended that an amended mine permit application would be submitted, showing an adjustment to the orientation of the pits, whereby more coal would become available for mining.

Topsoil and subsoil would be stripped in advance of each pass in two separate lifts. The average depth of topsoil stripped will be six to eight inches. Topsoil stripping will be accomplished by scrapers that will strip, transport, and deposit the topsoil on regraded areas or in topsoil storage areas. Crawler tractors will be used as needed to assist the scrapers in loading.

After topsoil has been removed from a sufficient area, subsoil will be removed to an average depth of 2.5 feet. Overburden will be drilled and blasted in preparation for stripping. The rubblized material will then be stripped using a dragline, assisted at times with mobile diesel equipment. This overburden will be cast into the empty pit remaining from the preceding cut after the coal has been removed. Overburden will be regraded to approximate original contour to comply with Montana's Strip and Underground Mine Reclamation Rules and Regulations as soon as adequate working room is available. Regrading will lag behind the mining operation by two spoil ridges during normal operations.

As the Rosebud coal seam is exposed in each pass, the coal will be drilled and blasted, and will then be excavated by loading shovels or mobile diesel equipment. These machines will load the coal into coal haulers, which will transport the coal to the new crusher facility for sizing to three-inch minus. The final product will be loaded onto the new overland conveyors for shipment to Colstrip Units 3 and 4.

The final cut will be backfilled and regraded using crawler tractors and scrapers. Final slopes no greater than 5:1 (20 percent slopes) will be achieved using material from the highwall reduction zone and final spoil ridge. Western Energy uses a 22 percent swell factor in calculating the post-mine topography.

4. Reclamation Plan

To comply with the Montana Strip and Underground Mine Reclamation Act, Western Energy must reclaim and restore all lands disturbed by

mining. Western Energy's proposed reclamation program includes topsoil and subsoil salvaging, backfilling, regrading, highwall reduction, drainage reconstruction, subsoil and topsoil redistribution, revegetation, and monitoring.

Western Energy is committed to a soil sampling program just prior to soil salvaging, in which a majority of the soils will be sampled using a Giddings soil sampler for electrical conductivity and texture. The results will be used to determine topsoil and subsoil salvage depths. As an erosion abatement technique, soils with excessively high sand content will be salvaged separately and placed on slopes of less than ten percent, away from drainage channels.

Prior to mining, soil will be salvaged using scraper haulers to the depths identified and staked during the pre-salvage sampling program. Spoil will be leveled using crawler tractors, and the final spoil surface scarified using bulldozer-mounted ripper bars. Salvaged soil will be hauled to a prepared regraded spoil surface or to a designated stockpile location. After subsoil and topsoil have been placed, the soil will be prepared by chisel plowing and discing using a farm tractor.

Revegetation of disturbed areas will be designed to return the land to livestock grazing and wildlife habitat uses. In a first phase of seeding, forbs, shrubs, and less competitive grasses will be planted using a Brillion seeder. Mulch will be applied on those areas with slopes exceeding ten percent using a modified stakprocessor. After an establishment period of one to three years, competitive cool-season grasses will be interseeded with a rangeland drill into the established first-phase seeding. In addition, patches of sandy soil materials of one acre or less will be seeded to a mixture of warm-season grasses adapted to sandy soils. Where feasible, existing shrubs and trees from areas to be disturbed will be transplanted to bottomlands and scattered upland areas using a tree spade. In addition, nursery-grown shrubs and tree tubelings will be used to reestablish shrub and woodland vegetation types. The areas to receive seedlings and the seed mixes included in Appendix G are shown on Figure I-8.

D. AREA C LIFE OF MINE PLAN

Western Energy has not formally submitted a life of mine plan for Area C beyond Block I to OSM or DSL. Figure I-9 shows the generally anticipated mining sequence and location for all mining in Area C, tentatively identified by Western Energy for comprehensive planning purposes.

Mining under the 34-year life of mine plan would recover approximately 166 million tons of coal (Table I-1). All coal from Area C would be transported to Colstrip generating Units 3 and 4 by the conveyor belt proposed in the Block I plan.

During the Area C life of mine under the Block II plan, coal production would proceed at an average annual rate of 4.9 million tons per

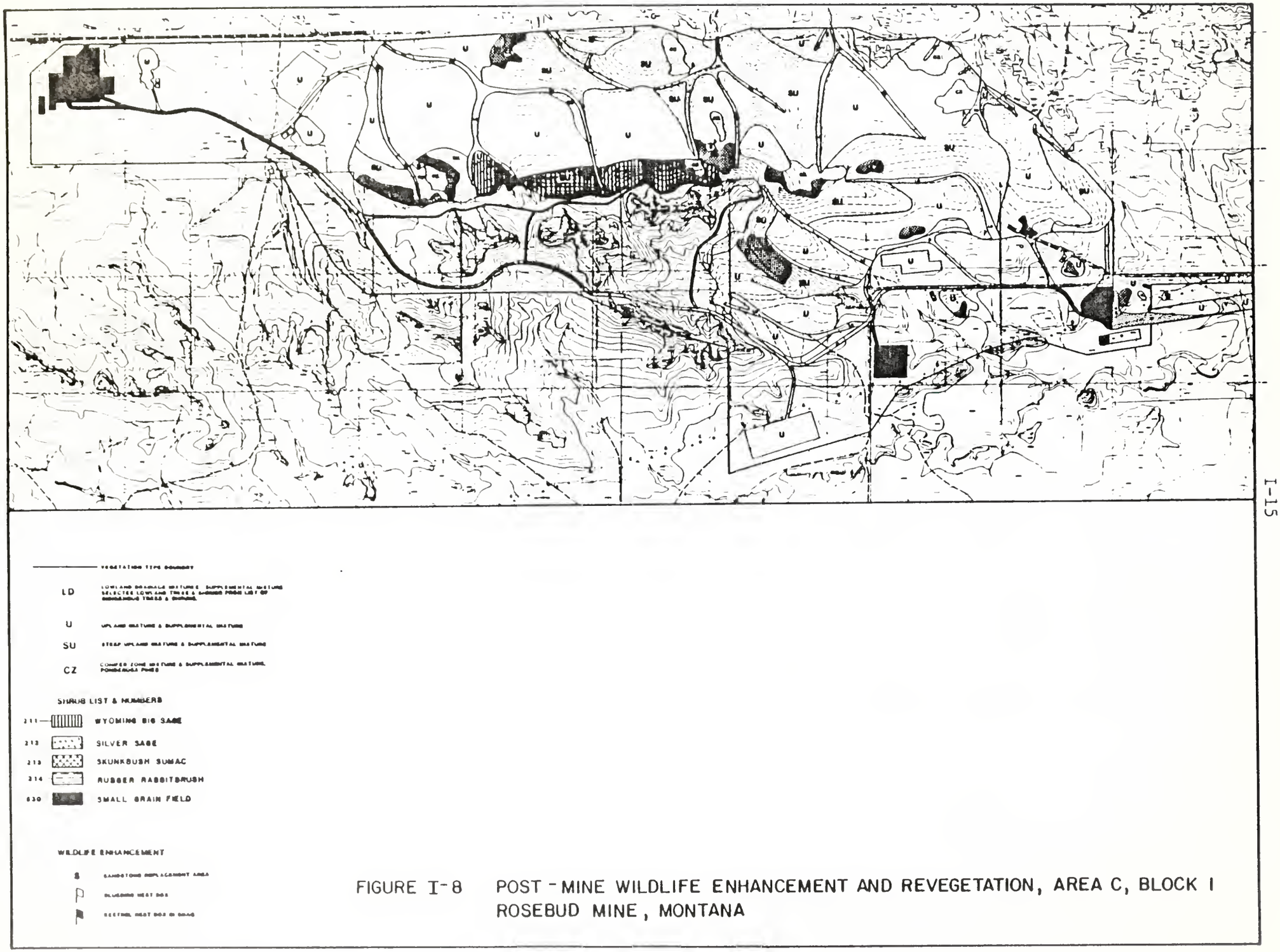


FIGURE I-8 POST-MINE WILDLIFE ENHANCEMENT AND REVEGETATION, AREA C, BLOCK I ROSEBUD MINE, MONTANA

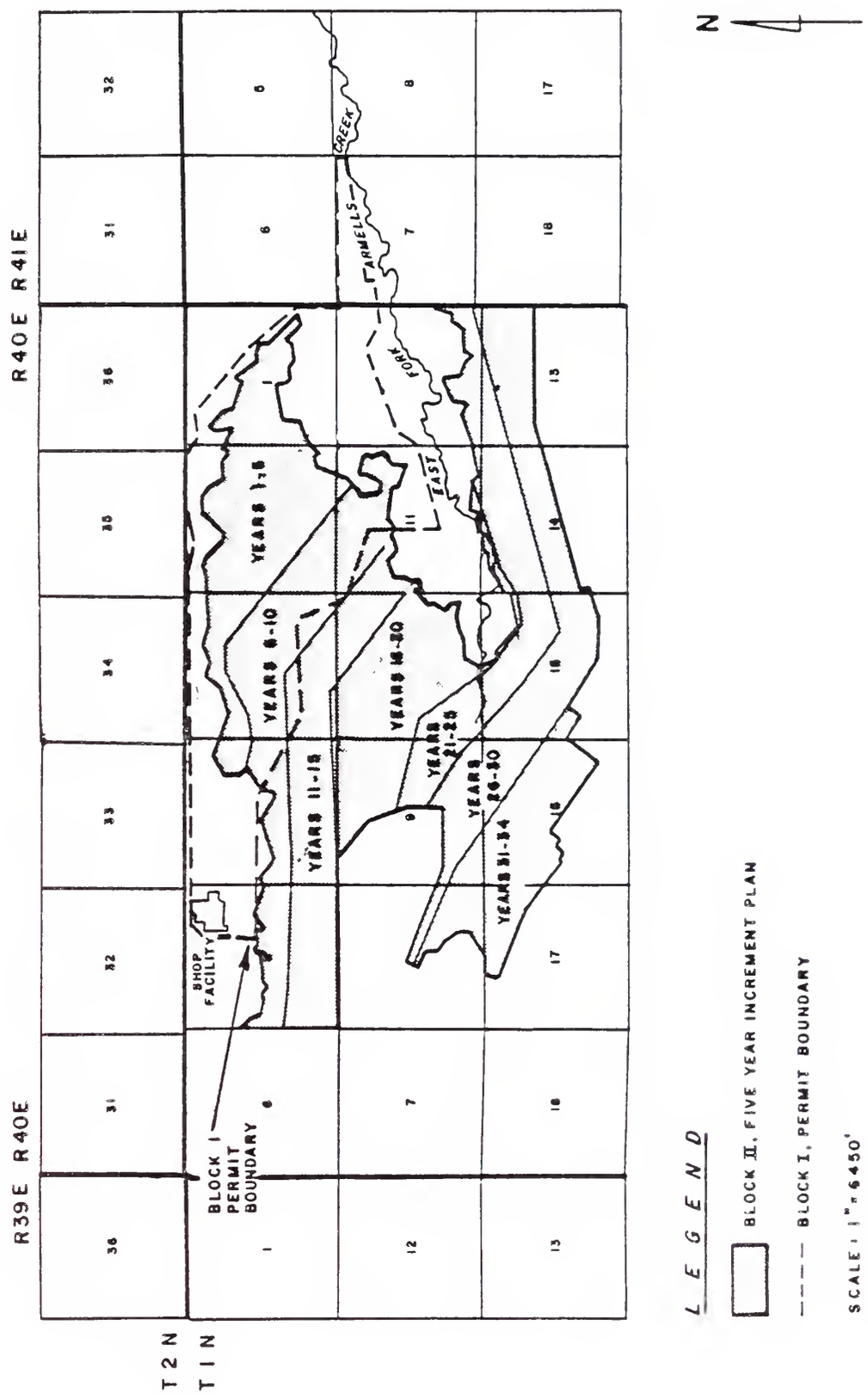


FIGURE I-9 -- BLOCK II, AREA C. LIFE OF MINE PLAN

year, resulting in an annual disturbance of approximately 148 acres. A total of approximately 5,040 acres would be mined in 34 years. In addition, about 2,862 acres would be disturbed by facilities, roads, the conveyor system, boxcut spoils, and highwall reduction activities. In Area C, a total of some 7,900 acres would be disturbed. No major facilities in addition to those proposed under the Block I plan would be required.

At any one time, mining and related disturbances would result in as much as one-eighth of the total 7,900 acres having no vegetative cover. This would include the period between initial topsoil salvage and seeding of the replaced soil on the regraded surfaces. Seeding failures caused by drought or other factors could increase the total areas not protected by vegetation.

CHAPTER II
DESCRIPTION OF THE EXISTING ENVIRONMENT

A. GEOLOGY

The proposed mine site is located on the gently-dipping northwest flank of the Powder River Basin. Geologic formations that are exposed in the lease area are limited to the Paleocene Fort Union Formation, Tongue River Member, and Quaternary Alluvium. Other formations in the region and subsurface mine area are described briefly in the columnar section depicted in Figure II-1.

1. Topography/Geomorphology

The Rosebud Mine lies within the unglaciated Missouri Plateau, a division of the Northern Great Plains Physiographic Province (Fenneman, 1931). The topography of this region is described by Keefer (1974) as being characterized by open high hills, with low to moderate relief.

Area C, Block I lies within the drainage basins of East Fork Armells Creek and Stocker Creek, both of which are intermittent streams draining away from the permit area in a northeasterly direction. Stocker Creek empties into East Fork Armells Creek north of the permit area and East Fork Armells Creek runs generally north from there to the Yellowstone River. No other drainages would be affected by the proposed mining activities. The drainage divides of East Fork Armells Creek and Stocker Creek drainage basins are formed by either prominent ridges of sandstone or resistant clinker caprock, or more rounded hills developed on siltstone units. Small ephemeral drainages start from close to these upland crests and drain toward the main channels. Elevations within the Area C, Block I permit area range from 3,440 feet to 3,680 feet.

The landforms in Area C have developed on the essentially flat-lying Tertiary sediments of the Fort Union Formation, and can be divided into five major map units. The characteristics of these units are summarized in Table II-1. Each landscape unit reflects modern processes acting on surficial materials with different geologic and geomorphic histories.

The most stable unit in the permit area is the Sandy Valley Bottom Unit (B_1), which covers 18.9 percent of Area C. The low sediment yields from this unit are a consequence of the high infiltration rates, low drainage densities, and gentle gradients characteristic of this landscape component. The silty residual upland unit (U_2), comprising 49.1 percent of Area C, is the most unstable unit. A moderate volume of runoff and sediment is derived from this unit. The relative unstability of this landscape component is partly a consequence of its geologic history. Incision due to base level lowering has removed any protective surficial deposits, exposing the underlying bedrock. On these residual slopes blanketed by soils with low infiltration capacities, hill slope erosion processes dominate, resulting in increased sediment yields. A dense vegetation cover (40 percent) appears to play an important role in moderating erosion within this unit.

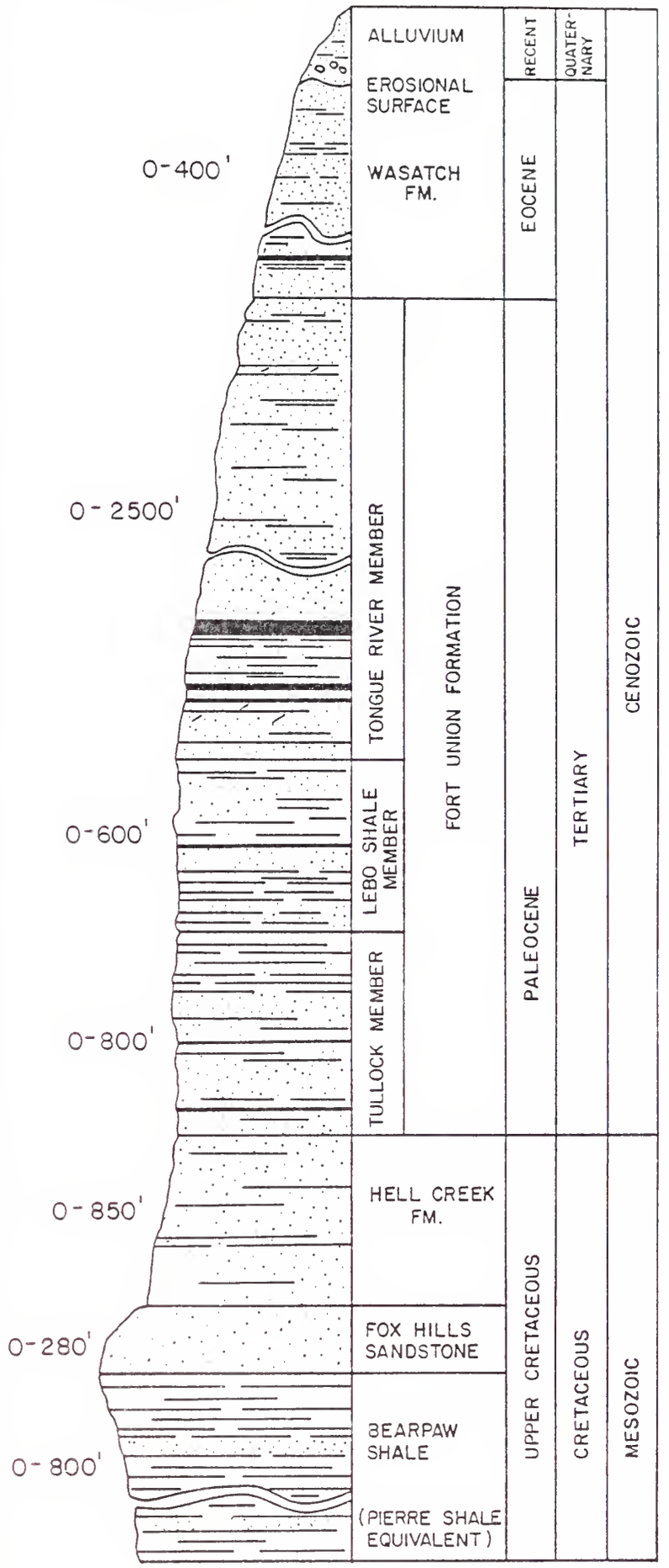


FIGURE II-1

GENERAL COLUMNAR SECTION OF UPPER CRETACEOUS AND CENOZOIC ROCKS IN THE COLSTRIP AREA, NORTHWESTERN POWDER RIVER BASIN, MONTANA
(After Lewis and Roberts, 1978)

ALLUVIUM - Sand, silt, clay, and local gravel lenses and benches

WASATCH - Brownish-gray to light-gray, fine- to coarse-grained lenticular beds of sandstone and interbedded gray shale and coal. Base of unit is mapped as the top of the thick and persistent Roland coal bed, as defined by Baker (1929). Locally eroded off in the Rosebud Mine permit area.

TONGUE RIVER - Light-yellow to light-gray, fine- to medium-grained thick-bedded to massive locally crossbedded and lenticular sandstone and siltstone; weathers to a buff color. Commonly contains light-buff to light-gray shaly siltstone and shale, and brown to black carbonaceous shale. Contains numerous coal beds. Burning of the coal along outcrops has formed thick red and lavender clinker and baked shale beds. Base of unit is mapped as the change from predominantly siltstone and sandstone to predominantly shale of underlying unit.

LEBO SHALE - Predominantly dark shale containing interbeds of light-gray and brown to black carbonaceous shale, siltstone, and locally thin coal beds. Shales contain altered and devitrified volcanic ash and brown ferruginous concretions. Base of unit is mapped as the change from predominantly shale to predominantly fine-grained sandstone and shale of underlying unit. Conformable contact with underlying unit; however the Lebo exists locally as deposits in channels eroded deeply into the underlying Tullock member.

TULLOCK - Lower part of member is interbedded medium-gray to light-gray shale, fine-grained light-gray sandstone and siltstone, and thin but persistent coal beds; grades upward to light-gray carbonaceous shale. Locally at the top is a resis- sandstone that forms a well-developed rimrock. Base of unit is mapped as the change from fine-grain, thin-bedded sandstone, siltstone, shale, and coal beds to predominantly massive channel sandstone and dark-gray shale of underlying unit. (Brown, 1952 and Dunlap, 1958)

HELL CREEK - Shale and siltstone, gray to yellowish-gray, silty, clayey, sandy, carbonaceous, and bentonitic; locally, a yellowish-gray to tan, fine- to medium-grained silty sandstone containing thin coal beds predominates. Lower contact is gradational. Contact probably unconformable with underlying Fox Hills Sandstone or Bearpaw Shale.

FOX HILLS SANDSTONE - Near-shore sand facies that is the uppermost marine deposit in the area. Two members are recognized: Colgate Member -- very light-gray, fine- to medium-grained massive sandstone. Unnamed lower member -- gray to brownish-gray, fine-grained thin-bedded sandstone, interbedded with gray sandy shale and siltstone. Lower contact is gradational, considered to be the base of transition zone between sandstone above and shale of underlying unit. Conformable contact with underlying unit.

BEARPAW SHALE - Gray to black marine shaly claystone and shale. Contains some thin-bedded siltstone and silty sandstone, and locally thin beds of bentonite.

TABLE II-1
CHARACTERISTICS OF LANDSCAPE UNITS IN THE COLSTRIP AREA

LANDSCAPE UNITS	% AREA C	% AREA C BLOCK 1	TYPES OF SURFICIAL MATERIALS	RANGE OF SLOPE GRADIENT	VEGETATIVE COVER (%)	DRAINAGE DENSITY (Mi/Mi^2)	INFILTRATION RATE In/Hr.	ESTIMATED SEDIMENT YIELD (AF/Mi^2)
B_1 SANDY VALLEY BOTTOM	18.9	16.8	Sandy alluvial dept. & weathered residual sandstone	8%	60-70	3.5	2-6	0.15
B_2 SILTY VALLEY BOTTOM	8.7	15.9	Deep alluvium silts	<8%	50	4.1	0.2-0.6	0.26
U_1 UPLAND SANDSTONE	23.3	32.7	Weathered -poorly lithified sandstone no rock fragments	8-15%	70	5.5	2-6	0.20
U_2 UPLAND SILTSTONE	49.1	34.6	Lacustrine units-silts & mudstone sandy facies	8-18%	40	7.3	0.2-0.6	0.73
U_3 CLINKER UPLAND	--	--	Clinker fractured resistant	15-20%	70-80	6.3	2-4	0.17
U_4 STEEP UPLAND UNIT	--	--	Fractured hard sandstone & siltstone w/ some massive formations	30%		4.7	4-6	0.22

The silty valley bottom unit is characterized by a low density of drainage lines (despite low surficial infiltration rates), apparently due to the destruction of channels by cultivation. As a consequence, the existing channel network may be inadequate to conduct runoff from this unit. To adjust, the network will tend to expand by entrenchment, resulting in increased sediment yields. This unit may, therefore, be potentially unstable. Sediment yields from the other landscape units in the permit area are estimated to be low, reflecting high infiltration capacities, resistant surficial materials, and a dense vegetative cover on these components.

East Fork Armells Creek and Stocker Creek both reflect strong bedrock and structural control (by faulting) on drainage basin and stream network development. This influence is strongest in the headwaters of these creeks and decreases downstream. Sediment yield from subbasins of these drainages in Area C is generally low, reflecting the high infiltration rate and the relative inefficiency of the vegetated ephemeral streams in transporting sediment. A discussion of the sedimentation rates and the method of calculation is presented in the Technical Support Document. The main channels within the basins are generally stable, while the smaller, ephemeral channels are less stable.

2. Stratigraphy

Quaternary deposits consist of weathered bedrock, colluvium, and unconsolidated clay, silt, and sand alluvium. In the five-year mine plan area, clinker deposits (locally known as scoria) have formed at and above the burned coal outcrop. Alluvial gravels are present in the East Fork Armells Creek Valley, which lies outside of Area C, Block I. Alluvium, colluvium, and clinker all constitute porous, near-surface aquifers of limited potential volume.

The Wasatch Formation has been removed by erosion in the Rosebud Mine area, and the only rock unit outcropping is the Tongue River Member of the Fort Union Formation. This member is predominantly a fine- to medium-grained silty sandstone with interbedded siltstone, silty shale, carbonaceous shale, localized clinker deposits, and coal beds. Pederson (Western Energy, 1981) states that the total thickness of the Fort Union Formation at Colstrip is 445 feet, with at least the top 360 feet being the Tongue River Member. Three coal seams in this member, in descending stratigraphic order, are the Rosebud, McKay, and Stocker. The coals dip generally one to two degrees southerly, with many local variations in the mine area as a result of small-scale folding, faulting, and localized thinning and thickening of coal seams and interburden.

3. Overburden

The overburden in Area C, Block 1 is composed of interbedded sandstone, siltstone, shale, and clinker, with various degrees of gradation between the units. Geochemical analyses of samples collected from drill holes in the overburden are presented in table form in Western Energy Company's Mining Permit Application for Area C, Block I, and in computer

printout form in the Technical Support Document for this EIS. The location of overburden test holes in Area C, Block I is shown in Figure II-2.

The overburden material was tested for 18 parameters (Western Energy Company, Mine Permit Application Area C, Block I, 1981); however, only seven of the 18 parameters tested showed significant values exceeding DSL suspect levels: electrical conductivity, molybdenum, cadmium, lead, nickel, zinc, and sand (See Appendix A, Table 1, for description of DSL suspect levels).

Because of the widespread contamination of samples by zinc- and lead-based drilling pipe joint grease, the anamalous lead and zinc values in the overburden have not been considered valid in this study. The remaining five parameters are shown graphically in Table II-2 by percentage of samples in each overburden hole that exceed state suspect level.

As Dollhopf et al. (1977, 1978, 1979) reported in their studies on the eastern part of Area B, the trace metals have a generally greater affinity for shale in the overburden than for other lithologies. In Area C this is particularly true of the shale immediately overlying the Rosebud coal seam.

4. Aquifers

Aquifers in the mine area include alluvial and colluvial deposits, Tongue River Member sandstones and coals, Lower Fort Union sandstones, and the lower Hell Creek-Fox Hills Sandstone (considered a single aquifer). In the mine area, only those aquifers above the McKay coal seam would be physically disturbed. A baseline description of these aquifers is presented in Section B, Hydrology.

5. Structure

The proposed mine area lies entirely within the northwestern portion of the Powder River Basin, a large depositional basin extending east into South Dakota, southward into Wyoming, and over thirty miles west and north from Colstrip. Superimposed upon this northwest flank of the Powder River Basin are numerous smaller scale structures, including the Ashland Syncline, a west-northwest trending shallow structural trough that cuts the southwest quarter of T1N, R40E. The axis of this syncline roughly coincides with the southwestern limit of proposed mining as shown in Western Energy Company's Comprehensive Mine Plan, Exhibit C (1981) (see Surficial Geology Map in the Technical Support Document).

Local doming, rolls, and minor folds are indicated in the Area C, Block I structural contour maps (Western Energy, Mine Permit Application, Area C, Block I, Volume 7, Exhibits T and U). No faults have previously been mapped in Area C, Block I, but in other sectors of the Rosebud Mine several faults have been mapped and/or inferred from aerial photos.

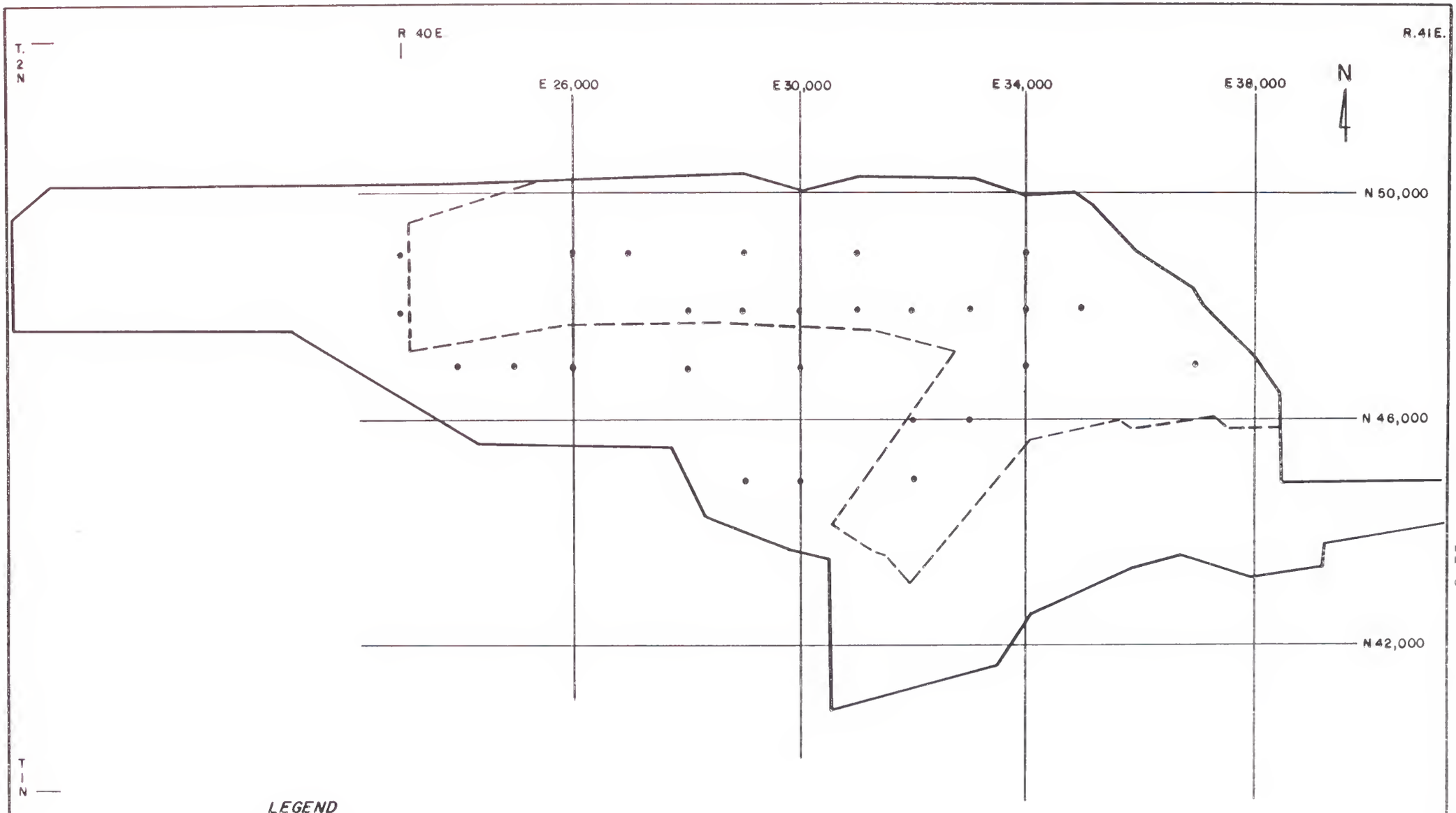


FIGURE II-2 OVERBURDEN GEOCHEMISTRY HOLE LOCATIONS
ROSEBUD MINE, MONTANA

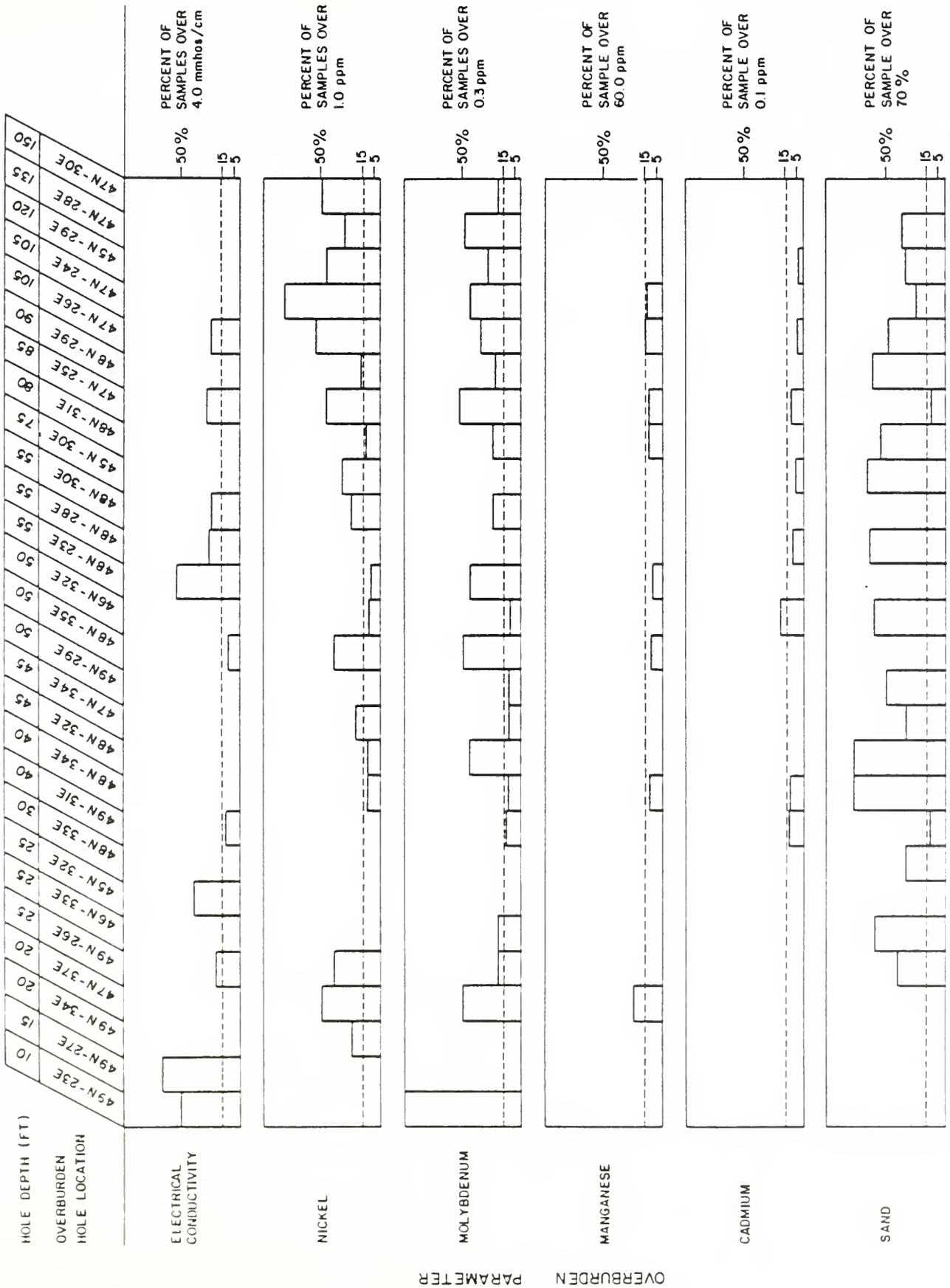


TABLE II-2 PERCENTAGE OF SAMPLES EXCEEDING STATE SUSPECT LEVELS IN OVERBURDEN TEST HOLES, AREA C, BLOCK I
ROSEBUD MINE, MONTANA

These faults have a strong west-northwest trend paralleling the Ashland Syncline axis.

Based on geologic cross sections from Western Energy's Area C, Block I Permit Application (Volume 7, Exhibit W) and topographic and air photo interpretation, a fault zone with at least two apparent faults is inferred in Area C, Block I. This zone trends northwest-southeast approximately through the northwest corner of Section 11 and halfway across Section 3, T1N, R40E. On cross section 46,000 N (Exhibit W) the northeastern-most inferred fault has a maximum displacement of greater than 70 feet down to the southwest. On cross section 29,000 E (Exhibit W) the southwestern-most inferred fault has a maximum displacement of 60 feet up to the southwest. It appears likely, from the evidence in the Exhibit W cross sections and topographic coincidence of linear features with anomalous dip changes in the sections, that some additional faulting along northwest-trending structures would be encountered in mining Block I. The same evidence suggests that such faults, if present, would likely have a displacement of less than 30 feet.

6. Geologic Hazards

There are no known significant geologic hazards in the proposed mine area. No active faulting is evident and the entire northern portion of the Powder River Basin is a tectonically stable area.

7. Paleontology

Fossil leaves and invertebrates of the Paleocene Period occur fairly abundantly throughout the Fort Union Formation and are likely to be encountered at the proposed mine. However, these are all common fossils and have limited scientific significance. No significant vertebrate fossils are known to occur in the Fort Union Formation (Taylor, 1975; U.S.D.I., 1978). There are no known fossil collecting sites in the mine permit area.

8. Resources

Natural resources occurring in the Northern Powder River Basin include coal, oil, gas, uranium, sand, gravel, and some clay. Of these, the coal resources are by far the most important.

Oil and gas exploration is currently active in Rosebud County, but no discoveries of oil or gas have been found in the area of the Rosebud Mine. No oil or gas wells have been drilled in Area C. The nearest oil and gas production to the mine area is in the Hardin field approximately 36 miles to the west, where gas is produced from the Mid-Cretaceous Frontier Formation. The nearest oil production to Colstrip is 48 miles north on the Porcupine Dome.

There are no known or indicated reserves of uranium in the Rosebud Mine area. Sand, gravel, and some clay are present in minor amounts.

Clinker deposits along the burned coal outcrop have been used for road gravel in the past.

Coal resources in Area C, Block I consist of the Rosebud, McKay, and Stocker seams, in descending stratigraphic order. The Rosebud seam is the primary coal seam of interest at the Rosebud Mine, and would be the only seam mined at Area C, Block I. Total in-place reserves in the Rosebud seam (Block 1) are approximately 27 million tons, of which Western Energy estimates 23.7 million tons recoverable in the Area C, Block I first five-year mine plan (see Table I-1). The Rosebud coal in Area C averages 8,348 Btu per pound and 0.86 percent sulfur (as received, proximate analyses).

The McKay coal seam lies below the Rosebud seam at an average interburden depth of 23 feet in Area C, Block I. The McKay averages eight feet thick, yielding approximately 9.6 million tons in place (calculated at 1,700 tons per acre-foot). Western Energy does not plan to mine the McKay coal for several reasons, which are discussed in depth in Chapters I and IV of this EIS. McKay coal in Area C averages 8,348 Btu per pound and 1.31 percent sulfur (as received, proximate analyses).

The Stocker seam lies between eight and nine feet below the McKay seam over most of Area C, Block I. This coal is of lower Btu value and higher sulfur content than the McKay seam. Average, as-received proximate values for 15 samples of the Stocker coal in Area C (Western Energy, analyses reports) yielded an average of 7,469 Btu per pound and 1.76 percent sulfur and exhibited an average thickness of 4.44 feet.

B. HYDROLOGY

The following section discusses groundwater and surface water systems, both on a regional scale and on a more localized scale (Area C, Block I). The regional data considered within this section is specific to the area of influence surrounding the existing Rosebud Mine, near the townsite of Colstrip. The general hydrologic setting within the study area is depicted on Figure II-3. The figure also illustrates the surface water drainage networks and coal seam outcrops*/subcrops* that have been examined during the preparation of this EIS.

The purposes of this section are to identify flow characteristics, quality and usage for both surface and groundwater systems, and also to identify the relationship between surface and groundwater throughout the hydrologic study area. Regional and site-specific characteristics of Area C, Block I will be discussed under each of the major topical headings, particularly when site-specific characteristics deviate somewhat from the regional characteristics.

Primary information on the hydrology of the Rosebud Mine area was obtained from site-specific reports completed in the past ten years. Western Energy's data base includes information on groundwater, surface water, and water quality. Data was also obtained from published reports and ongoing studies on the general hydrology of the area prepared by Montana Bureau of Mines and Geology, United States Geological Survey (USGS), and the Environmental Protection Agency (EPA). In addition, existing regional and site-specific Environmental Impact Statements (EIS), Montana Power Company special reports, state documents, Peabody Coal Company's data base, and Montana State University Agricultural Experiment Station research documents were also used.

1. Groundwater

The discussion on groundwater includes:

- The physical and hydraulic properties of each water-bearing unit
- The characteristics of groundwater flow in each unit
- Groundwater quality
- Groundwater use

In some instances, the characteristics of Area C, Block I are different from the hydrologic study area as a whole. Appropriate comparisons are made in these instances.

a. Water-bearing Strata

Groundwater and geologic studies (Section A.2) have identified seven near-surface geologic units within the Rosebud Mine area that can store and transmit water (Figure II-4). The water-bearing strata are (from youngest to oldest):

* Indicates the first appearance of a term defined in the Hydrology Glossary

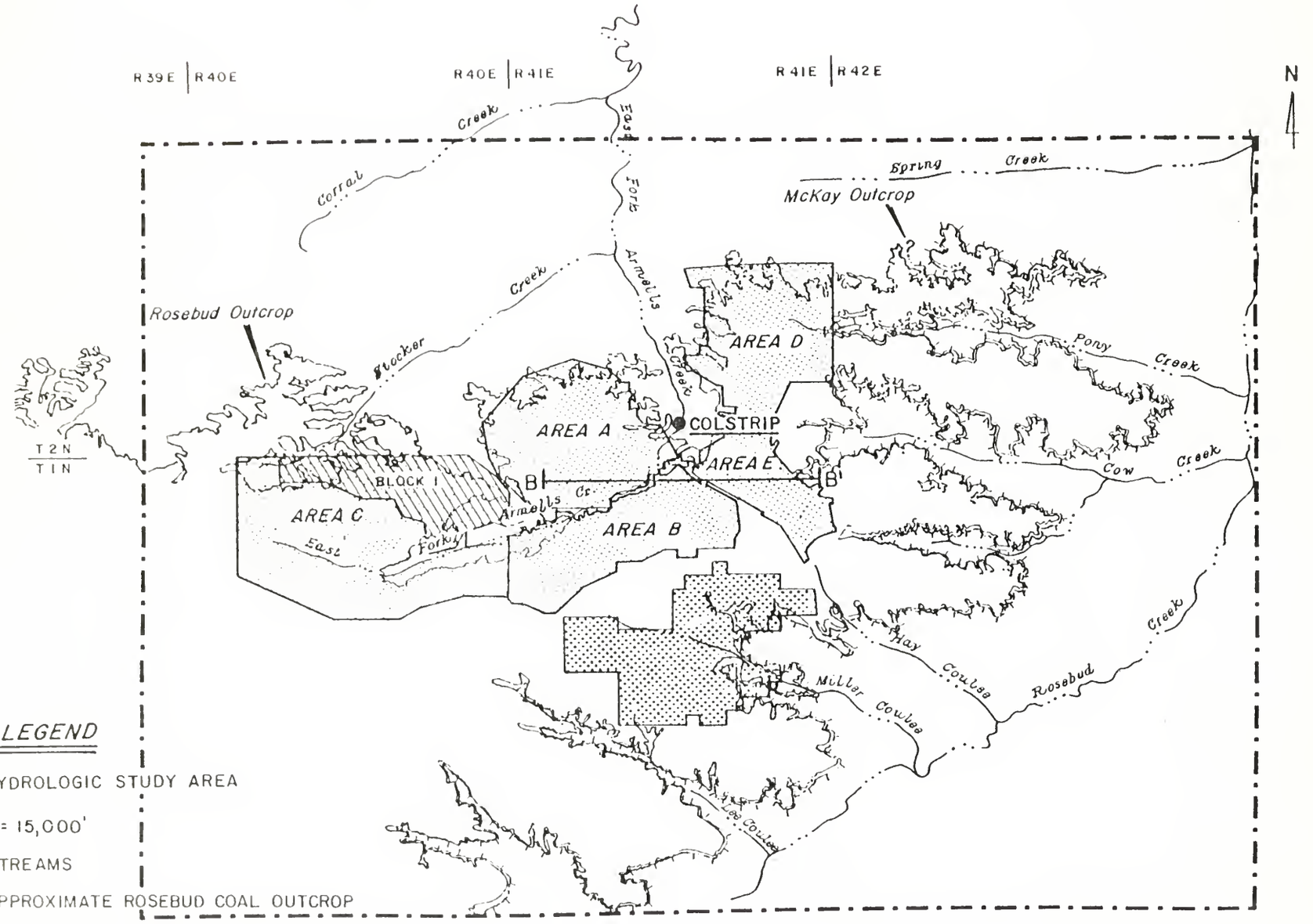
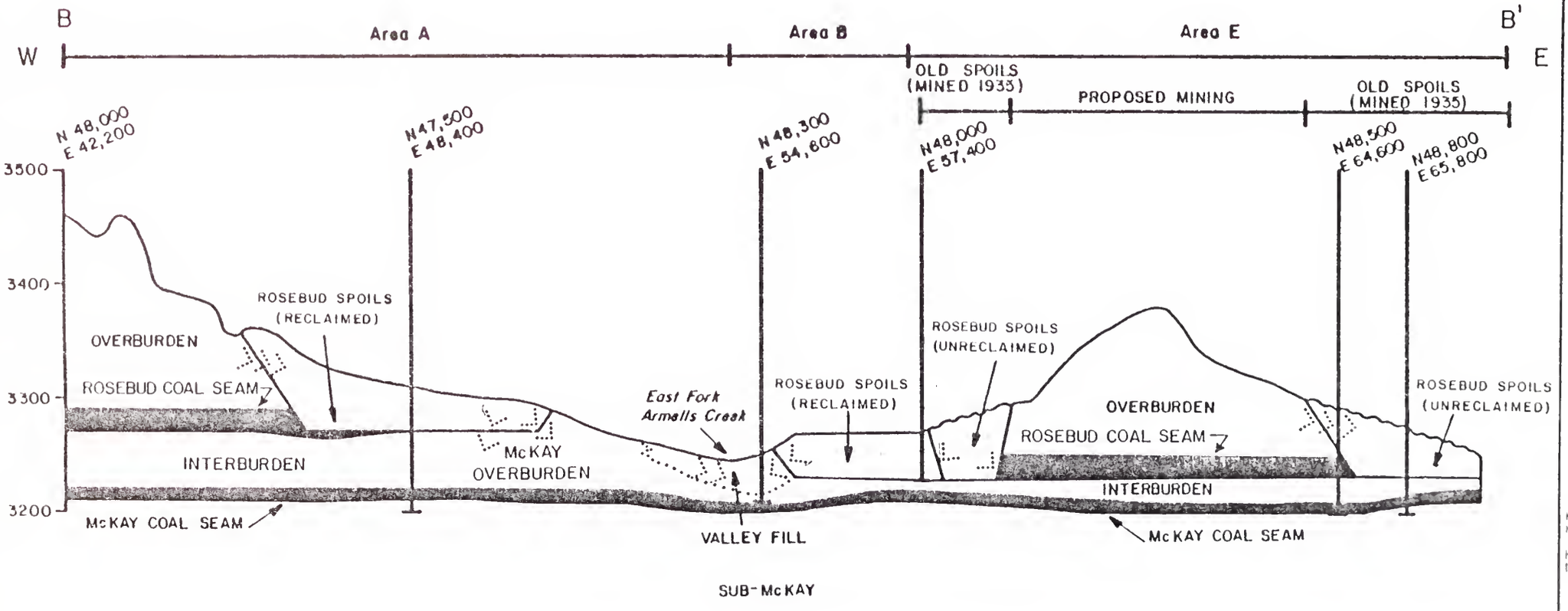


FIGURE II-3 HYDROLOGIC STUDY AREA SHOWING DRAINAGES WITH APPROXIMATE COAL SEAM OUTCROPS/SUBCROPS



LEGEND

HORIZONTAL SCALE: 1" = 2790'

VERTICAL SCALE: 1" = 143'

VERTICAL EXAGGERATION: 20X

DIRECTION OF GROUNDWATER MOVEMENT

SEE FIGURE II-2 FOR LOCATION OF CROSS SECTION B-B'

FIGURE II-4 SCHEMATIC CROSS SECTION OF GROUNDWATER MOVEMENT THROUGH SPOILS AND SURROUNDING MATERIAL, ROSEBUD MINE AREA, MONTANA

- o Rosebud spoils*
- o Valley fill material*
- o Rosebud coal overburden*
- o Rosebud coal
- o Rosebud/McKay interburden*
- o McKay coal
- o Sub-McKay

The following is a description of the physical and hydraulic properties for each of these water-bearing units. The discussion relates to the hydrologic study area in general (Figure II-3), except as qualified by site-specific references in the text. Sub-section 8, entitled "Area C Characteristics" describes properties that are specific to Area C. In general, however, the properties identified for water-bearing units are consistent throughout the hydrologic study area.

1) Rosebud Spoils

The Rosebud spoils consist of reworked Rosebud coal overburden material, which has been replaced where the Rosebud coal has been mined out.

Since the dragline operation deposits spoils parallel to the stripping operation, spoils exhibit higher linear porosity* coincident with the direction of the dragline movement. Due to the linear nature of the spoils, permeability* values also vary directionally. Data from aquifer* tests in the spoils indicate a mean transmissivity* value of 2,000 gallons/day/ft, a median transmissivity value of 61 gpd/ft, and a range of transmissivity values of <1 to 23,400 gpd/ft (see Table II-3).

Rosebud spoils in previously mined areas vary in thickness from less than one foot near the coal outcrop to over 120 feet in Rosebud Mine Areas A and B. A more permeable rubble zone has been noted (Van Voast et al., 1978) at the base of the spoils. This zone consists of waste coal and larger rock fragments that roll to the bottom of the spoils during stripping. According to Van Voast et al. (1978), the rubble of boulders and wasted coal at the base of the spoils is probably responsible for the large range of transmissivity values. Generally, however, Van Voast found that hydraulic conductivity* values for the spoils were similar to the hydraulic conductivity values of the aquifers they replaced.

2) Valley Fill Material

The materials comprising the valley fill system consist of alluvial* and colluvial* deposits. These deposits consist of interbedded silts, sands, gravels, and clays and are generally less than 40 feet thick. In the Rosebud Mine area valley fill material is found in stream bottoms and on terraces*, which are situated approximately 10 to 20 feet above the stream bottoms. Colluvial and alluvial material intermingle where the hillsides merge with the alluvial terraces, and are often difficult to differentiate.

The large range of particle sizes, from boulder-sized colluvial fragments to clay-sized particles in the alluvial deposits, along with the lenticular nature of the valley fill deposits has an effect on the direction of groundwater flow in this system. These lenses of alluvial material in the valley fill system result in zones of variable hydraulic conductivity. Table II-3 lists the available transmissivity and hydraulic conductivity values for all wells tested in the study area that show this variability. Most valley fill aquifer tests were performed along East Fork Armells and Stocker Creek drainages.

Botz (1979) and Van Voast (1977) state that storage coefficients ranging from 0.1 to 0.3 are typical for the valley fill material. Transmissivities for the East Fork Armells Creek valley fill range from 6 to 74,800 gpd/ft for 29 tests. The mean and median transmissivity values are both approximately 10,000 gpd/ft.

Valley fill material in Stocker Creek appears to consist of the same material present in East Fork Armells Creek, but exhibits a narrower range of transmissivity values (2,200 to 50,000 gpd/ft). Only six tests, however, have been conducted in the Stocker Creek drainage. Due to the greater number of tests performed on East Fork Armells Creek, the mean value of these aquifer tests is more representative of shallow groundwater transmissive characteristics.

It should be noted that the mean and median values for transmissivity and hydraulic conductivity (Table II-3) are highest for the valley fill aquifer, as compared to the other water-bearing strata underlying the area. This is mainly due to the coarse-grained nature of some of the valley fill materials.

3) Rosebud Coal Overburden

Rosebud overburden is found throughout the area overlying the Rosebud coal, and is composed of brown to gray, very fine- to medium-grained sand, shale, claystone, and clinker*. Overburden thickness varies from zero at the Rosebud coal outcrop/subcrop to over 240 feet beneath the sandstone ridges in Area C. The sandstone, shale, and claystone are interbedded and discontinuous, so that the ability of the aquifer to transmit water is variable from well to well.

The overburden is generally considered to be an unconfined* aquifer, although in some areas it does show confined* characteristics. Twenty-two aquifer tests conducted in the Rosebud overburden indicated a range of transmissivity values from 1 to 79,000 gpd/ft. The mean (8,950 gpd/ft) and median (57 gpd/ft) values vary by approximately 8,900 gpd/ft. This wide variation in transmissivity may be due to the discontinuity of the lithologic units in the overburden (Geology, Section A.3). Faults and fracturing in the overburden in Area B (Plate B-1, Technical Support Document) could be responsible for the high transmissivity values (79,000 gpd/ft) in that area.

An overburden aquifer pumping test was performed at well WX-101, 2-1/2 miles southwest of Colstrip along East Fork Armells Creek (Figure

TABLE II-3

SUMMARY OF TRANSMISSIVITY AND HYDRAULIC CONDUCTIVITY VALUES
FOR AQUIFER TESTS IN THE ROSEBUD MINE AREA

	TRANSMISSIVITY				HYDRAULIC CONDUCTIVITY			
Aquifer	Number of Aquifer Tests	Range of Values (gpd/ft)[1]	Mean Value (gpd/ft)	Median Value (gpd/ft)	Number of Values Used in Analysis[2]	Range of Values (ft/day)[3]	Mean Value (ft/day)	Median Value (ft/day)
E. Fork Armells Valley Fill	25	6-74,800	12,600	9,900	23	6.400-501.3	119.50	102.50
Stocker Cr. Valley Fill	6	2,200-50,000	18,900	5,300	--	--	--	--
Spoils	17	0.24-23,400	2,000	61	17	0.001-65.3	6.02	0.30
Rosebud Overburden	23	1-79,000	8,950	57	12	0.006-3.8	0.47	0.02
McKay[(a)] Overburden	9	230-2,600	1,500	570	--	--	--	--
Rosebud Coal	35	3-12,700	526	30	35	0.005-68	5.17	0.12
Interburden(b)	8	1-210	43	7	8	0.002-0.9	0.15	0.01
McKay Coal	24	1-560	147	104	18	0.002-3.6	0.72	0.15
Sub-McKay	6	90-3,200	860	470	--	--	--	--

-- no data available

1. gallons per day per foot
2. conductivity values were not calculated for all aquifer tests because of lack of information
3. feet per day

(a) McKay overburden - Rosebud coal does not exist above the McKay coal unit

(b) Interburden - Rosebud coal overlies the McKay coal unit.

II-5), where data from four observation wells were analyzed. Storage coefficients ranging from 0.006 to 0.03 were calculated from this test and indicate that in this area the overburden shows confined to semi-confined* conditions. The mean (0.468 ft/day) and median (0.015 ft/day) hydraulic conductivity values indicate a very low rate of flow through the aquifer. Recovery data on both the pumped well and observation wells indicate that there is a lower permeability boundary* in the vicinity of the well, since the transmissivity values decrease from 45,000 gpd/ft to 8,000 gpd/ft between 10 and 30 hours after pumping has ended.

In some areas, the overburden includes clinker, which is usually brittle and highly fractured. According to Dollhopf (1978), fractures in the clinker create potential areas of groundwater recharge or discharge. However, there have been no aquifer tests in the clinker at the Rosebud Mine to confirm this postulate.

4) Rosebud Coal

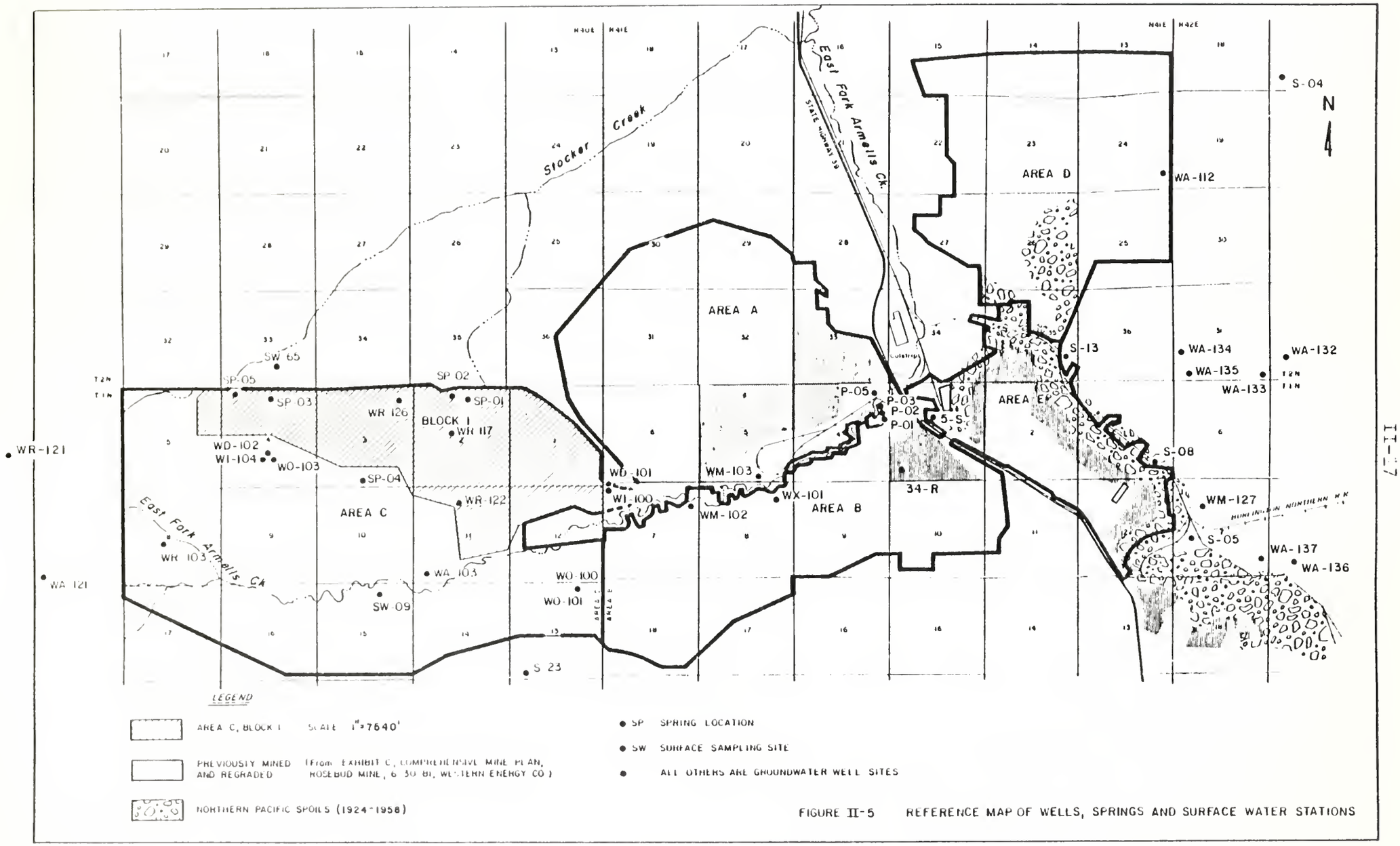
The Rosebud coal varies in thickness from zero at the outcrop to approximately 24 feet, and has an average thickness of 22 feet. The coal is locally fractured and folded, resulting in an increase in porosity* and permeability.

The Rosebud coal aquifer is confined over most of the mine area, except where it crops out or subcrops, along Pony and Cow Creek drainages. A broad range of transmissivity values has been calculated for the Rosebud coal. The results of 37 tests range from 3 to 12,700 gpd/ft. The mean transmissivity is 526 gpd/ft, and the median value is 30 gpd/ft. The wide range is probably the result of the inconsistent fracture pattern that is characteristic of the coal bed. The ability of the aquifer to transmit water is directly proportional to the degree of fracturing in the coal.

A constant discharge test of the Rosebud coal aquifer was conducted at well 34-R, one mile south of Colstrip (Figure II-5), where two observation wells were monitored. The storage coefficient was calculated to be about 0.000015, which is within the typical range of 0.00001 to 0.001 for confined aquifers. One observation well, completed in overburden material, was not affected by the drawdown test at the pumped well, indicating that the two aquifers are not connected in that area.

5) Rosebud/McKay Interburden

The Rosebud and McKay coal seams are separated by 10 to 100 feet of interburden. The average interburden thickness varies from 40 to 60 feet in the Rosebud Mine area and consists of clays and shales that act as confining layers. The interburden contains more clay than the overburden and is considered to be a less productive water-bearing stratum. However, fractures and lithologic changes in the interburden may allow some exchange of groundwater between the Rosebud and McKay aquifers in some areas.



LEGEND

AREA C, BLOCK I SCALE 1"=7640'

PREVIOUSLY MINED AND REGRADED (From EXHIBIT C, COMPREHENSIVE MINE PLAN, ROSEBUD MINE, 6-30-81, WESTERN ENERGY CO.)

NORTHERN PACIFIC SPOILS (1924-1958)

● SP SPRING LOCATION

● SW SURFACE SAMPLING SITE

● ALL OTHERS ARE GROUNDWATER WELL SITES

FIGURE II-5 REFERENCE MAP OF WELLS, SPRINGS AND SURFACE WATER STATIONS

The interburden between Rosebud and McKay coal seams exhibits a mean transmissivity of 43 gpd/ft, and a median transmissivity value of 7 gpd/ft. The range of transmissivity values (1 to 210 gpd/ft) is the lowest for any of the aquifers. Some fractures and faulting have caused anomalously high transmissivity values, but as a unit it appears that the clays and shales characteristic of the interburden are responsible for inhibiting the groundwater flow through this aquifer.

Lithologically, the McKay overburden and the interburden are the same unit, but, in areas where the Rosebud coal has been eroded (refer to Figure II-4), the material above the McKay coal exhibits characteristics of an unconfined aquifer*. Transmissivity values for the McKay overburden range from 230 to 2,600 gpd/ft, with a mean of 570 gpd/ft and median of 1,500 gpd/ft. These values are higher than those for the interburden, indicating a difference in hydrologic characteristics between these two units. This is probably because the interburden is confined by a coal seam; whereas the McKay overburden is associated with brittle clinker in some areas.

6) McKay Coal

The McKay coal is approximately 8 to 12 feet thick in the Colstrip area and exists over most of the area shown on Figure II-3.

The McKay coal is a confined aquifer in the Rosebud Mine area and its porosity and permeability are related to fracturing in the coal seam. According to Van Voast (1977), storage coefficients for both the Rosebud and McKay aquifers are within the same range (0.00001 - 0.0001). However, the transmissivity of the McKay coal aquifer ranges from 1 to 560 gpd/ft (24 tests), which is considerably lower than the range of values for the Rosebud coal aquifer. This is due to the fact that the McKay coal is thinner than the Rosebud coal (transmissivity is a function of thickness). Assuming that the Rosebud and McKay aquifers have equivalent hydraulic conductivities, the thicker Rosebud coal aquifer can transmit more water per unit width than the McKay coal.

7) Sub-McKay

The regional sub-McKay aquifer consists of sandstone and sandy clays in the Tongue River Member of the Fort Union Formation. The sub-McKay unit underlies the McKay coal and ranges from 20 to 250 feet beneath the surface in the Rosebud Mine area. The Lebo Shale Member of the Fort Union Formation forms an areally extensive impermeable base to the sub-McKay unit.

Available information indicates that the sub-McKay is a confined aquifer system; however, very little hydraulic data exists for the sub-McKay. Transmissivity values from six aquifer tests in the sub-McKay range from 90 to 3,200 gpd/ft and have a mean and median of 860 and 470 gpd/ft, respectively.

8) Area C Characteristics

The physical properties of the water-bearing strata are generally the same throughout the hydrologic study area, including Area C. However, the average Rosebud/McKay interburden thickness is approximately 20 feet greater in Area C than the average for the whole area. Also, because of the existence of sandstone ridges the overburden is up to 240 feet thick in Area C, which is about 90 feet thicker than anywhere else in the Rosebud Mine.

Very little hydraulic data exists for Area C. Specifically, ten aquifer tests were performed in the valley fill material, three in the overburden, eight in the Rosebud coal, one in the interburden, one in the McKay coal, and no tests were performed in the sub-McKay coal (see Plate B-1 for locations of tests).

The mean hydraulic conductivity for Area C valley fill is 104 ft/day. This compares favorably with the calculated mean hydraulic conductivity of 119.5 ft/day for East Fork Armells valley fill in the hydrologic study area.

The mean hydraulic conductivity for the Area C overburden is 0.4 ft/day; however, not enough data exists to statistically compare test results with the hydraulic characteristics of the hydrologic study area.

The average transmissivity value in the Rosebud coal in Area C is 190 gpd/ft. This is lower than the average transmissivity for the hydrologic study area. There is no apparent reason for this difference; it may be due to natural lithologic variations within the coal.

The McKay coal and Rosebud/McKay interburden Area C hydraulic characteristics can not be compared to the hydrologic study area test results because only one aquifer test was performed in each aquifer in Area C.

b. Groundwater Flow

The following section will discuss the nature of groundwater flow in the hydrologic study area and, more specifically, Area C. Flow will be defined by: 1) focusing upon the type and direction of flow within each water-bearing stratum; 2) identifying the way in which significant quantities of water move between aquifers; 3) discussing where and how groundwater recharge and discharge occurs; and 4) discussing which aspects of flow in Area C are most significant, as compared with the hydrologic study area in general.

First, before preceding with the discussions outlined above, there are some important overall trends in groundwater flow that should be summarized briefly to provide the reader with a general introduction to groundwater flow systems in the Rosebud Mine area.

- The most significant bedrock groundwater flow exists in the Rosebud and McKay coal seams. Flow velocities are not large,

but they have a higher relative conductivity than the Rosebud overburden or Rosebud/McKay interburden units.

- Bedrock flow generally follows the south-southeast structural gradient of about one-half percent. Deviations in regional flow patterns occur in the vicinity of mine pits, in areas of structural highs and lows, and where coal seams crop out and subcrop.

- A major recharge area appears to be located in the vicinity of Area C.

- Some bedrock discharge occurs along upper East Fork Armells Creek although just above Colstrip the situation reverses and the valley fill along East Fork Armells Creek recharges bedrock.

- Flow in spoil and valley fill originates either by direct infiltration of precipitation or by inflow from bedrock.

- Flow directions in spoils are highly dependent upon the placement of spoil and can't be easily generalized.

- Flow direction in valley fill is generally parallel to the direction of the stream channel.

- Minor deviations in flow direction in valley fill material result from the recharge-discharge relationship with bedrock aquifers; the seasonally controlled amount of net infiltration (from precipitation); and an influx of water to the valley fill from a leaking surge pond downstream of Colstrip.

1) Nature of Flow Within Water-Bearing Strata

The seven water-bearing strata have varying types of flow (i.e., confined and unconfined) and also have varying flow directions. Generally, aquifers of regional extent, such as the Rosebud coal aquifer, show regional flow directions from the northwest to southeast. However, less extensive strata (such as spoils, valley fill, and to some extent the Rosebud coal overburden) tend to have a less uniform flow direction.

The following discussion summarizes flow characteristics in each of the seven water-bearing strata.

a) Rosebud Spoils

The inflow and outflow of spoils groundwater is illustrated schematically in Figure II-4. The groundwater in the spoils is generally unconfined; however, it should also be noted that there is evidence to suggest that spoils water may be confined in some areas.

Figure II-6 is a potentiometric map of the Rosebud Spoils aquifer which clearly shows the lack of uniformity of flow within the spoils.

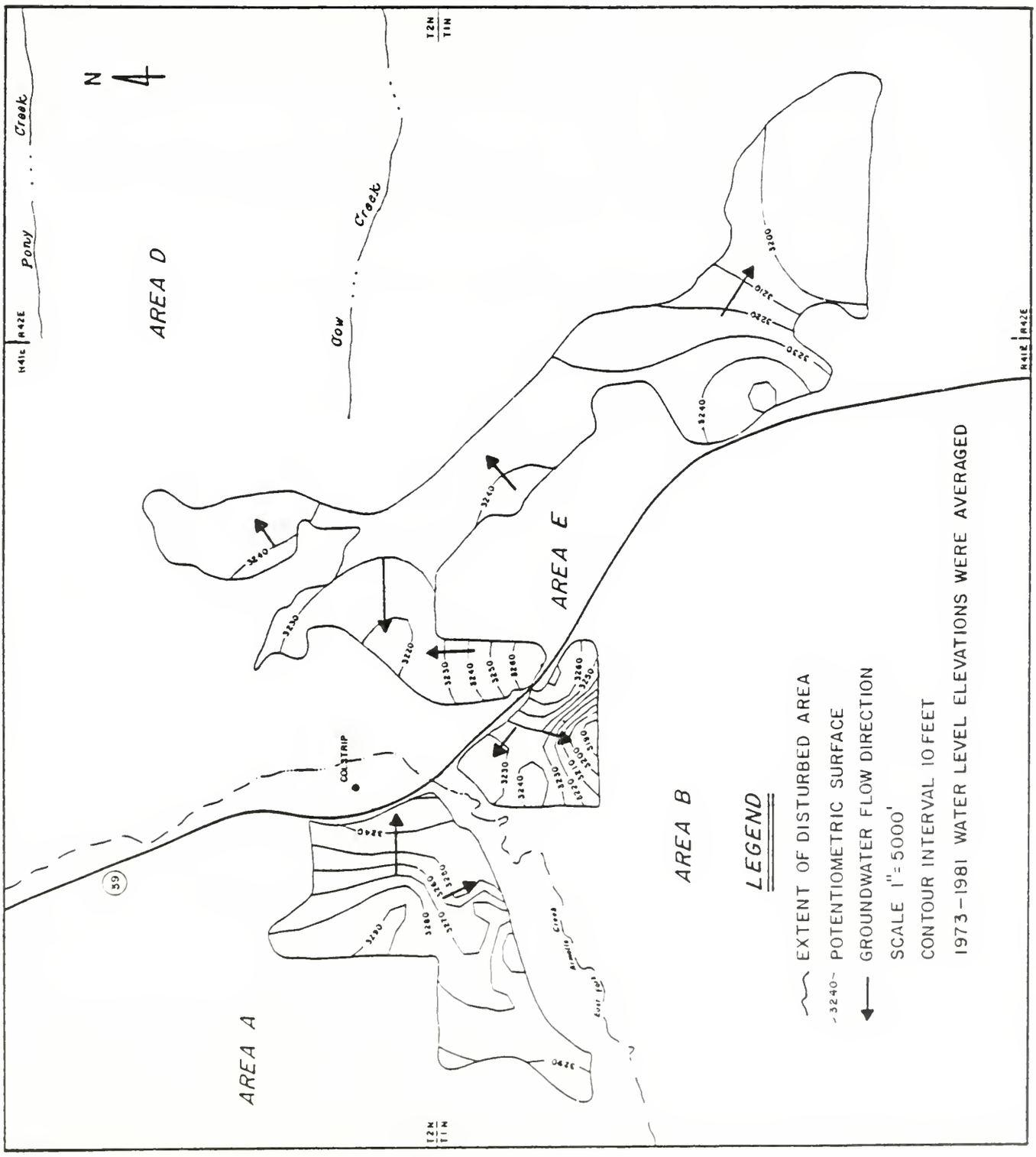


FIGURE II-6 POTENTIOMETRIC SURFACE OF SPOILS AQUIFER, ROSEBUD MINE, MONTANA

The following variations in flow direction occur within the Rosebud spoils:

- Where Rosebud spoils abut a bedrock face left from mining, and overlie the McKay overburden, groundwater flows laterally from Rosebud overburden and Rosebud coal into the spoils and then laterally into the spoils and Rosebud coal and perhaps vertically into the McKay overburden.

- Where Rosebud spoils are located adjacent to other valley fill material, as it is along portions of East Fork Armells Creek, spoils water may originate from bedrock discharge to the spoils or from direct infiltration.

- Where Rosebud spoils become part of the valley fill groundwater flow system, spoils water migrates laterally into valley fill.

b) Valley Fill Material

Groundwater flow in the valley fill system generally parallels the stream channel, as indicated on Figure II-7. This general relationship seems to hold true not only along East Fork Armells Creek and Stocker Creek but also for smaller valley fill systems that are tributary to East Fork Armells Creek. Review of static water levels appears to demonstrate that water levels and, to an extent, the direction of flow in the valley fill, depend upon net infiltration of precipitation. This relationship, discussed in more detail in Section 3 (Hydrology), shows that water levels decline in summer when evapotranspiration is high and precipitation is low. In winter, when precipitation is higher and evapotranspiration is minimal, water levels tend to rise. When water levels rise in winter, equipotentials are deflected toward the stream because the channel has a more significant dewatering effect on valley fill when groundwater levels are higher.

The direction of flow within valley fill is also affected somewhat by whether or not valley fill is receiving bedrock discharge (as in the upper reaches) or is recharging the bedrock (as in the lower reaches) (see Section 1.b.2). Because valley fill permeabilities are so much higher than those of bedrock strata this discharge-recharge relationship doesn't greatly affect valley fill groundwater equipotentials.

c) Rosebud Coal Overburden

There is not enough water level data for the Rosebud overburden to construct an accurate potentiometric map for the overburden. It appears that the general gradient of water in overburden follows the structural gradient of 0.5 to 1 percent to the southeast. Groundwater is not laterally continuous throughout the overburden, but where there is a saturated condition, the groundwater may be either confined or unconfined. The source of water in the overburden is probably due to direct infiltration of precipitation, but may also be due to upward leakage from the Rosebud coal. Limited seepage may occur at locations where the overburden has been truncated by mining or where it crops out.

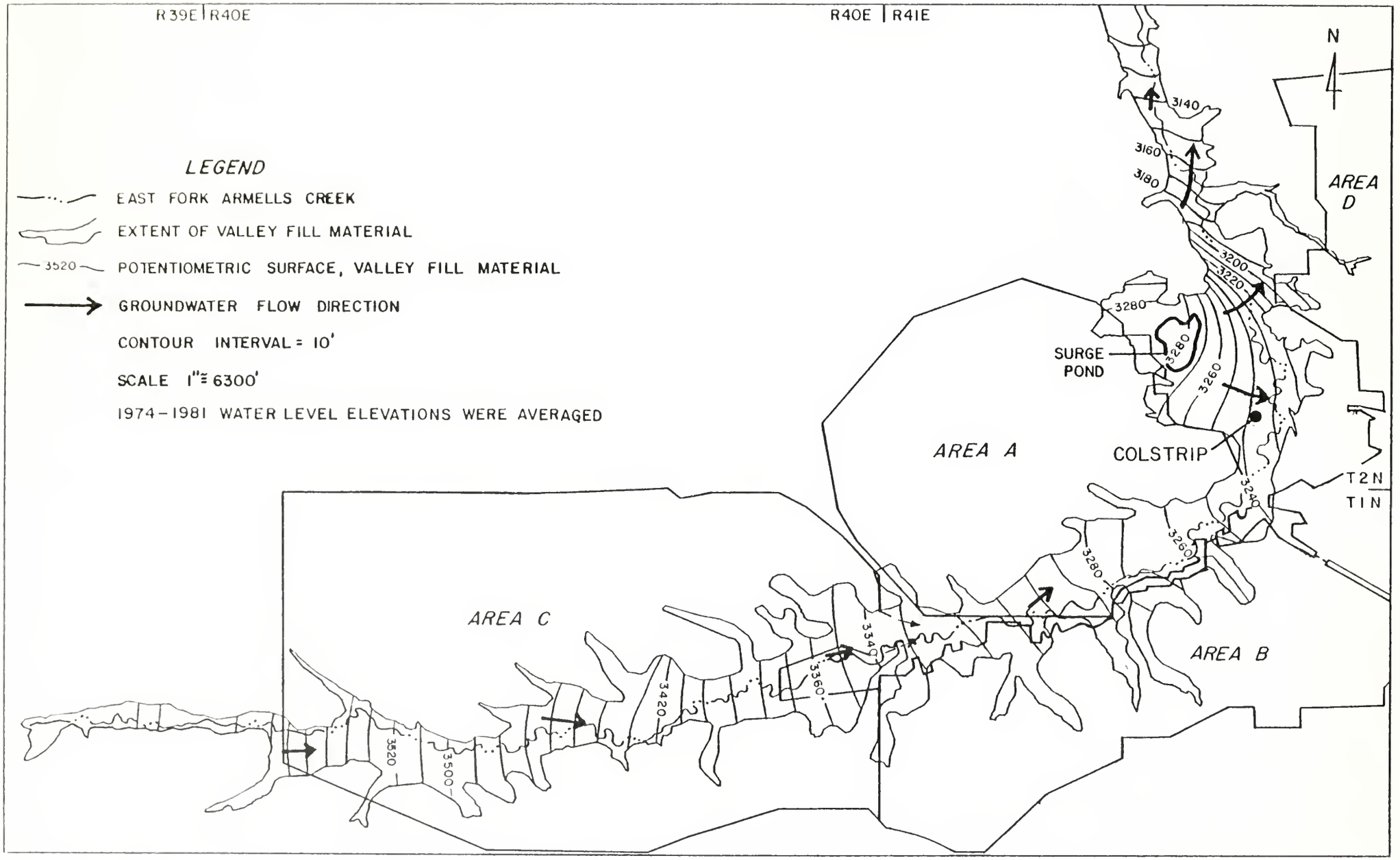


FIGURE II-7 POTENTIOMETRIC SURFACE MAP OF VALLEY FILL AQUIFER
ROSEBUD MINE, MONTANA

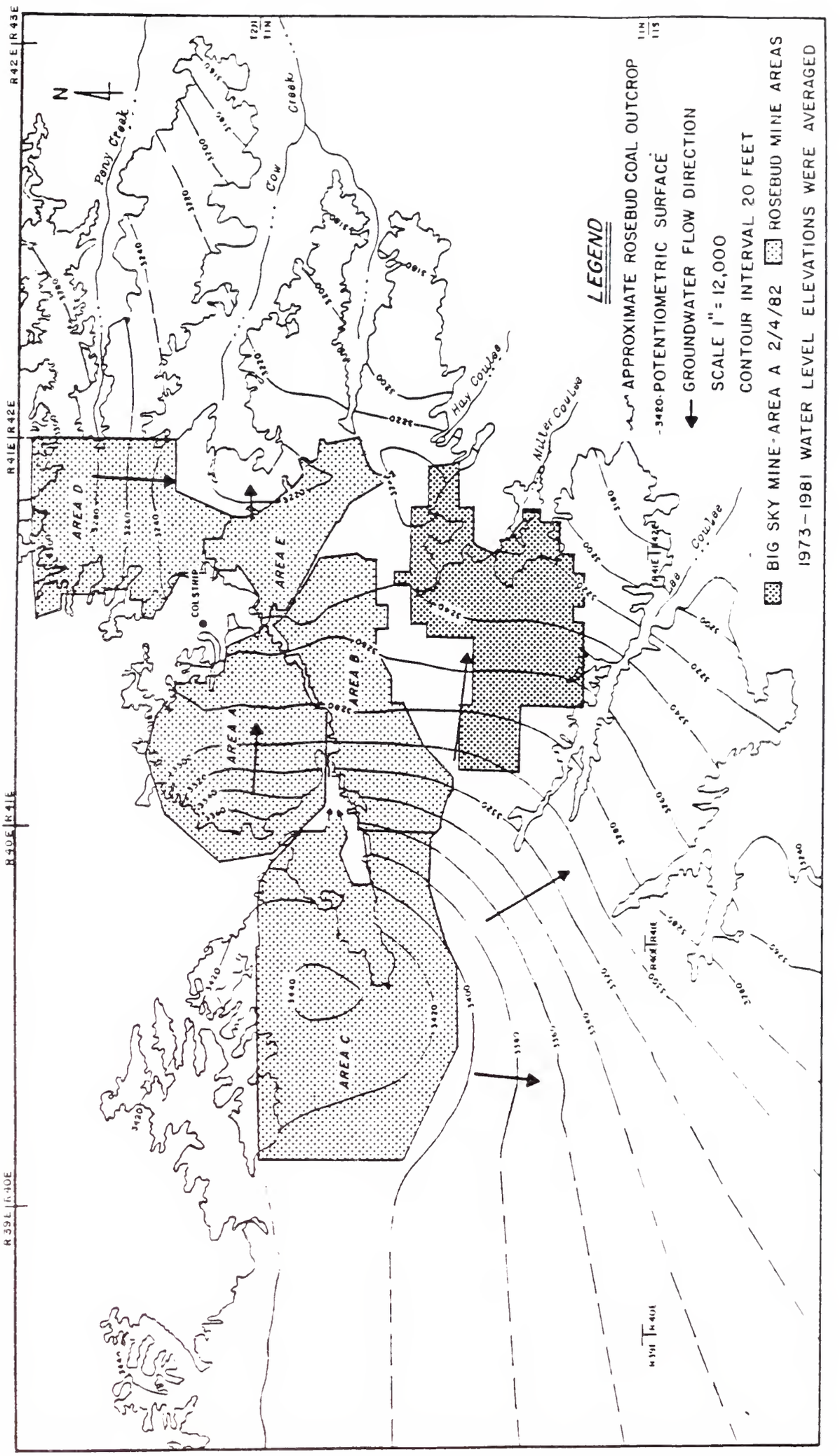


FIGURE II-8 REGIONAL POTENTIOMETRIC SURFACE OF ROSEBUD COAL AQUIFER, ROSEBUD & BIG SKY MINES, MONTANA

d) Rosebud Coal

The direction of groundwater flow within the Rosebud coal aquifer is illustrated in Figure II-8. It can be seen that the regional flow originates in the vicinity of Area C and moves from that groundwater high to the south, southeast and east. As with flow in the overburden, the hydraulic gradient in the Rosebud coal aquifer follows the structural dip of the unit.

Conditions in the Rosebud coal aquifer vary from confined to unconfined, as shown in Figure II-9, where the bedrock is cut by two high-angle faults, one normal* the other a reverse* fault. It is not clear whether or not the faulting has caused groundwater conditions to become unconfined, or if it is because the Rosebud coal seam is almost entirely exposed between the faults. The faults do not appear to cause significant changes in the regional lateral direction of flow in the Rosebud. The fact that the coal has been offset, but the flow remains unaffected, seems to indicate that vertical hydraulic communication is occurring across the fault zone. It is possible that the faulted area provides an excellent conduit for vertical groundwater flow.

e) Rosebud/McKay Interburden

As with the Rosebud overburden, the nature of flow in the Rosebud/McKay interburden has not been well defined. Basically, as with the overburden, the interburden is probably largely unconfined, with discontinuous lateral saturation. The regional direction of flow is probably structurally controlled (i.e., northwest to southeast). Water occurring in the interburden probably comes from minimal leakage downward from the Rosebud coal and upward from the McKay coal.

f) McKay Coal

Figure II-10 illustrates the nature of regional flow in the McKay coal aquifer. Flow directions are very similar to those observed for the Rosebud coal aquifer, and are, once again, controlled by the structural dip of the rock unit.

g) Sub-McKay

Although a large percentage of domestic wells are completed in the sub-McKay unit there is little specific data on the nature of groundwater flow. The aquifer is confined by a 30-foot thick layer of clay situated at the top of the sub-McKay unit. This clay layer effectively separates flows in the sub-McKay from the McKay coal aquifer. It is probable that the southeast structural dip of the sub-McKay controls the direction of flow, as is the case with the Rosebud and McKay coal aquifers.

2) Aquifer Communication

There are four major modes of communication between water-bearing strata:

- o Vertical leakage from the McKay coal seam
- o Movement along faults

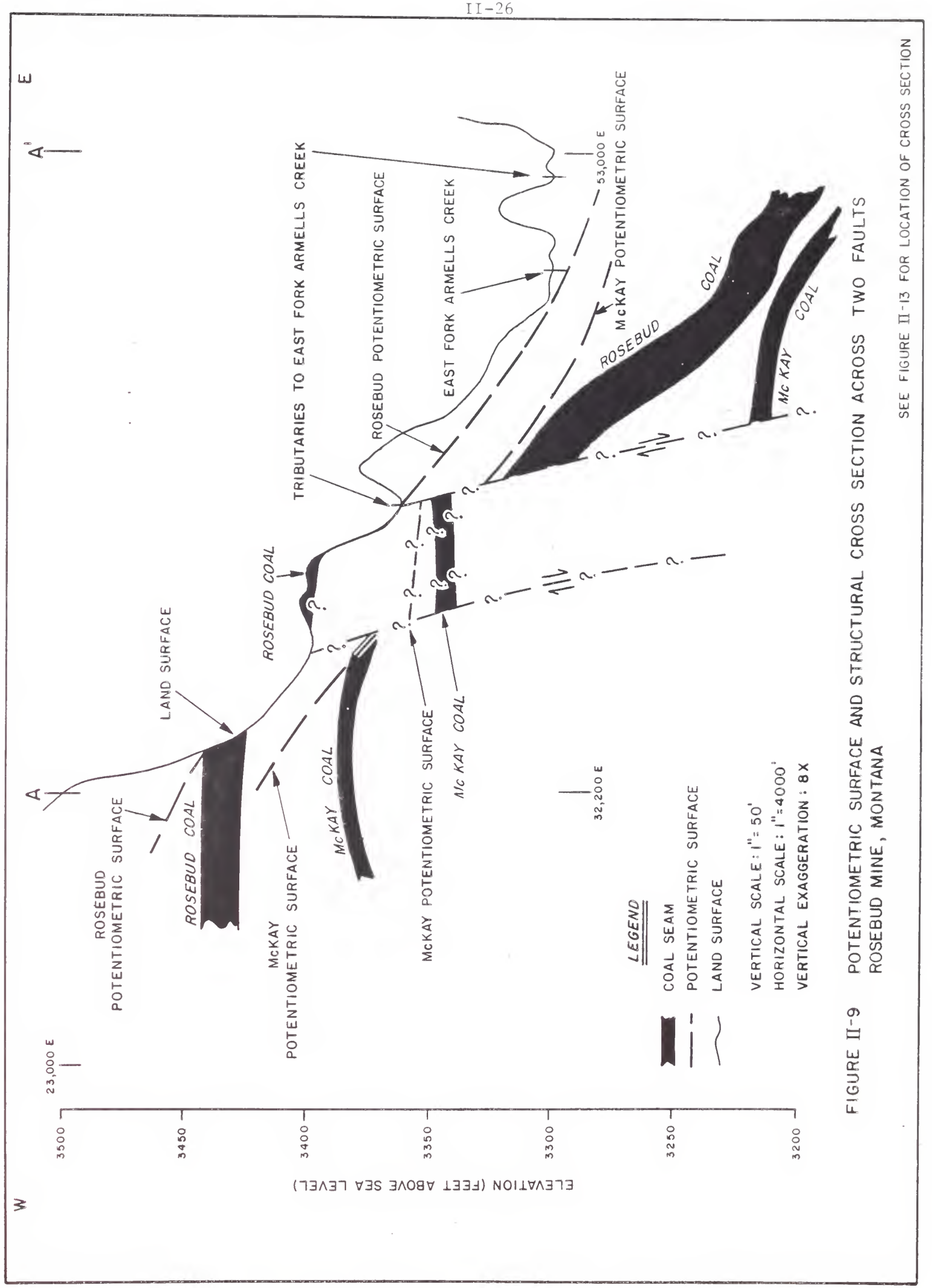


FIGURE II-9 POTENTIOMETRIC SURFACE AND STRUCTURAL CROSS SECTION ACROSS TWO FAULTS ROSEBUD MINE, MONTANA

SEE FIGURE II-13 FOR LOCATION OF CROSS SECTION

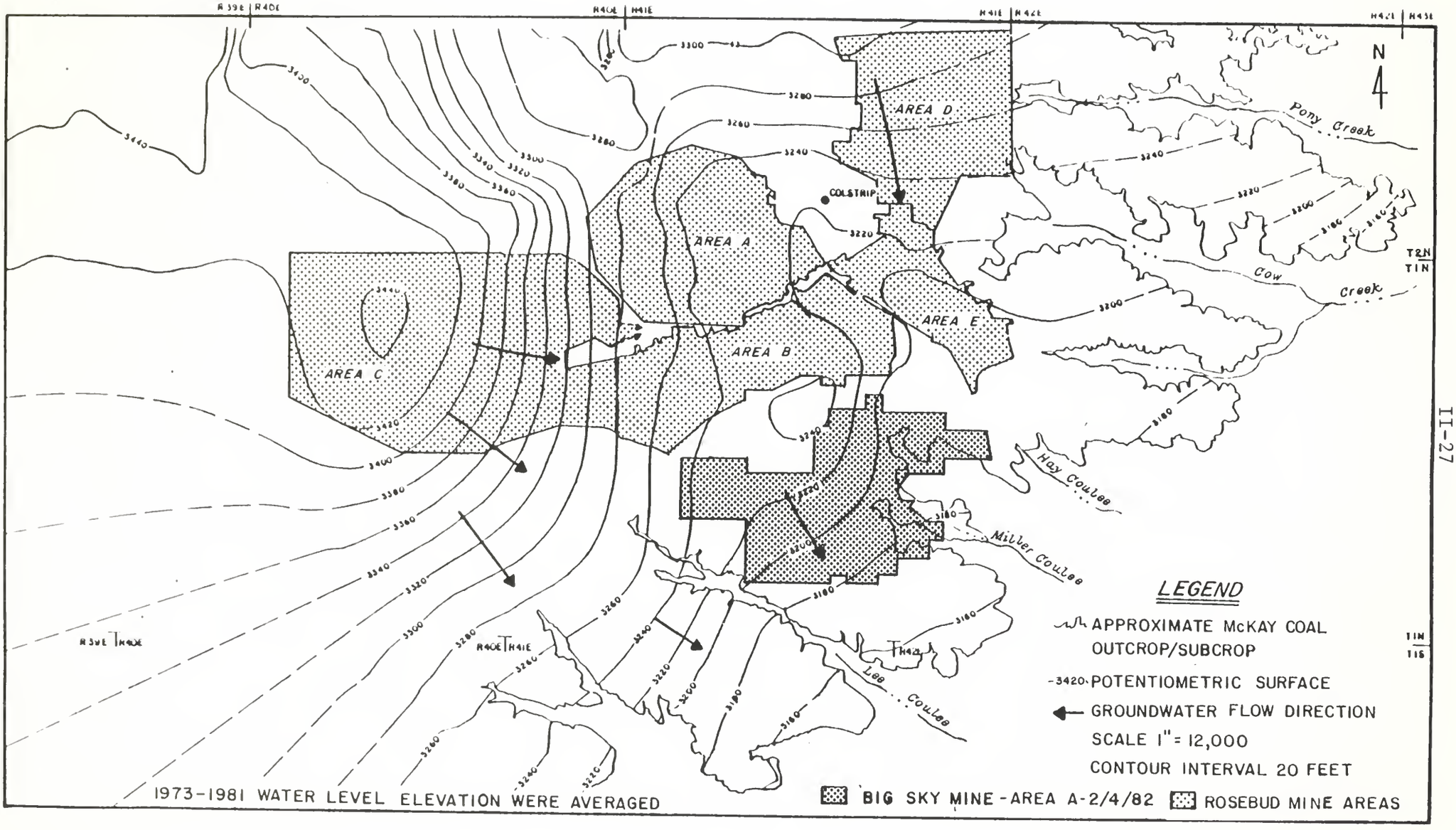


FIGURE II-10 REGIONAL POTENTIOMETRIC SURFACE OF McKAY COAL AQUIFER, ROSEBUD & BIG SKY MINES, MONTANA

- o Exchange between consolidated* and unconsolidated* materials
- o Exchange betwen two unconsolidated, water-bearing strata

Water levels in Area B wells WM-102 and WM-103 (refer to Figure II-5) completed in the McKay coal have been observed to decline. This indirectly suggests that mining of the Rosebud coal in Area B has allowed for an increase in upward vertical leakage from the McKay coal seam.

As previously mentioned, two high-angle faults cut both the McKay coal and the Rosebud coal west of Colstrip. The fact that groundwater becomes unconfined in the vicinity of these faults and there are some anomolously high transmissivities in bedrock aquifers close to the fault suggest the possibility that the faults and related fractures allow for intermingling of water between the McKay and the Rosebud coal seams.

Clearly, wherever the spoils or valley fill material are in direct contact with bedrock strata the potential exists for either the bedrock to discharge to unconsolidated strata, which is most common, or for the spoil or valley fill to recharge the bedrock.

In some areas along East Fork Armells Creek, Rosebud coal spoils have been placed in direct contact with valley fill. There is no clear subsurface evidence to indicate that spoils are in direct contact with valley fill in any other drainages. Where the spoils in contact with East Fork Armells Creek valley fill receive significant infiltration or inflow from bedrock, groundwater may flow laterally through the spoils into the valley fill. However, this contribution to the valley fill is probably not significant, as compared with the normal flow through valley fill.

3) Groundwater Recharge-Discharge

Groundwater recharge and discharge is usually inferred from groundwater flow data. In an area where there is a high point on a potentiometric surface (or groundwater contour) map water must flow away from that area. Also, water must be contributed to the aquifer as recharge in that area in order for the groundwater high point to be maintained.

Discharge may be inferred by places where groundwater contours come to the surface and the strata transmitting the water either crops out or comes close enough to surface for discharge to occur. The relationship is, of course, not always simple and many gray areas exist.

Rosebud spoils receive net infiltration (or recharge) from precipitation during the autumn to spring period. It is probable that this net infiltration is higher in unreclaimed spoils than reclaimed spoils. This difference is probably due to the fact that reclaimed spoils are revegetated, which caused higher evapotranspiration values than in unreclaimed spoils, where natural revegetation may occur slowly. It is also due to the hummocky* nature of unreclaimed spoils where precipitation is trapped in depressions, causing it to infiltrate rather than run off.

Figure II-11 depicts recharge and discharge areas in valley fill material along East Fork Armells Creek. For most of its course above

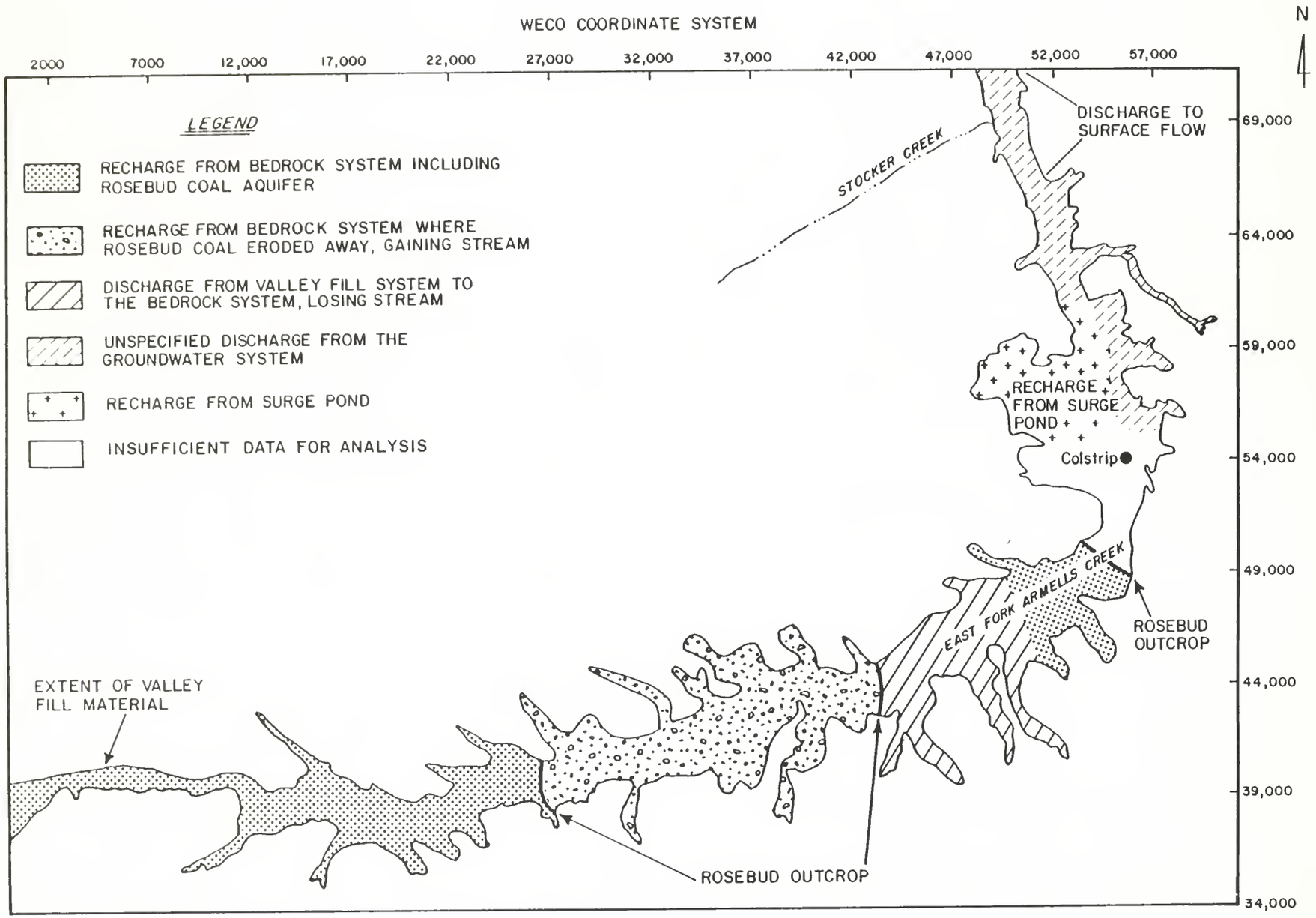


FIGURE II-11 RECHARGE / DISCHARGE AREAS OF THE VALLEY FILL MATERIAL FOR EAST FORK ARMELLS CREEK, ROSEBUD MINE AREA, COLSTRIP, MONTANA

Colstrip townsite, the valley fill is receiving discharge from underlying and adjacent bedrock and from adjacent spoils. For a short section, the valley fill becomes a losing* system as it recharges bedrock just above the townsite of Colstrip. Immediately above and below Colstrip insufficient data exist to establish a relationship; however, it is logical to assume that the valley fill continues to recharge the bedrock in this area.

Farther below Colstrip, the MPC power plant surge pond is located along the western flank of the valley. As shown schematically in Figure II-12 the surge pond is in direct contact with valley fill materials in a minor tributary to East Fork Armells Creek. Valley fill groundwater contours of East Fork Armells Creek show the influence of seepage from the surge pond on the valley fill. This influence is visible as a groundwater mound, causing flow to move perpendicular to the direction of the creek, rather than subparallel to it. It is probable that surge pond leakage contributes to bedrock recharge, because groundwater flow in the valley fill is recharging bedrock throughout this reach of East Fork Armells Creek.

Figure II-13 illustrates the recharge-discharge areas for the Rosebud and McKay coal aquifer within the hydrologic study area. Most recharge appears to occur in the vicinity of Rosebud Mine Area C, the headwaters of East Fork Armells Creek. As the groundwater moves south, southeast and east away from the bedrock recharge areas, a small percentage is discharged to spoils or valley fill adjacent to East Fork Armells Creek. However, the major portion of the groundwater is carried by the two coal aquifers and moves southeastward to discharge points along the outcrops of both aquifers, as illustrated in Figure II-13. The figure shows that significant discharge occurs along a series of gullies that are tributary to Rosebud Creek. Although the Rosebud overburden and Rosebud/McKay interburden follow the same structural trend, they do not transmit much water, and, thus, have not been considered with respect to recharge-discharge.

As mentioned previously, the amount of net infiltration to the valley fill depends upon the season. In summer, the valley fill groundwater is being diminished by baseflow and plant uptake, while during autumn, winter and early spring there is net positive infiltration to the valley fill.

4) Groundwater-Surface Water Relationship

The relationship between surface water and groundwater in the hydrologic study area has been addressed, to a great extent, by discussing recharge and discharge of groundwater. Within the hydrologic study area, groundwater from bedrock is discharging to valley fill and hence to surface water along minor reaches of East Fork Armells Creek above Colstrip. For a segment of East Fork Armells Creek above (and probably below) Colstrip, the stream and the valley fill is recharging the bedrock aquifer.

Farther to the southeast, a major groundwater discharge zone occurs along a series of coulees tributary to Rosebud Creek (refer to Figure

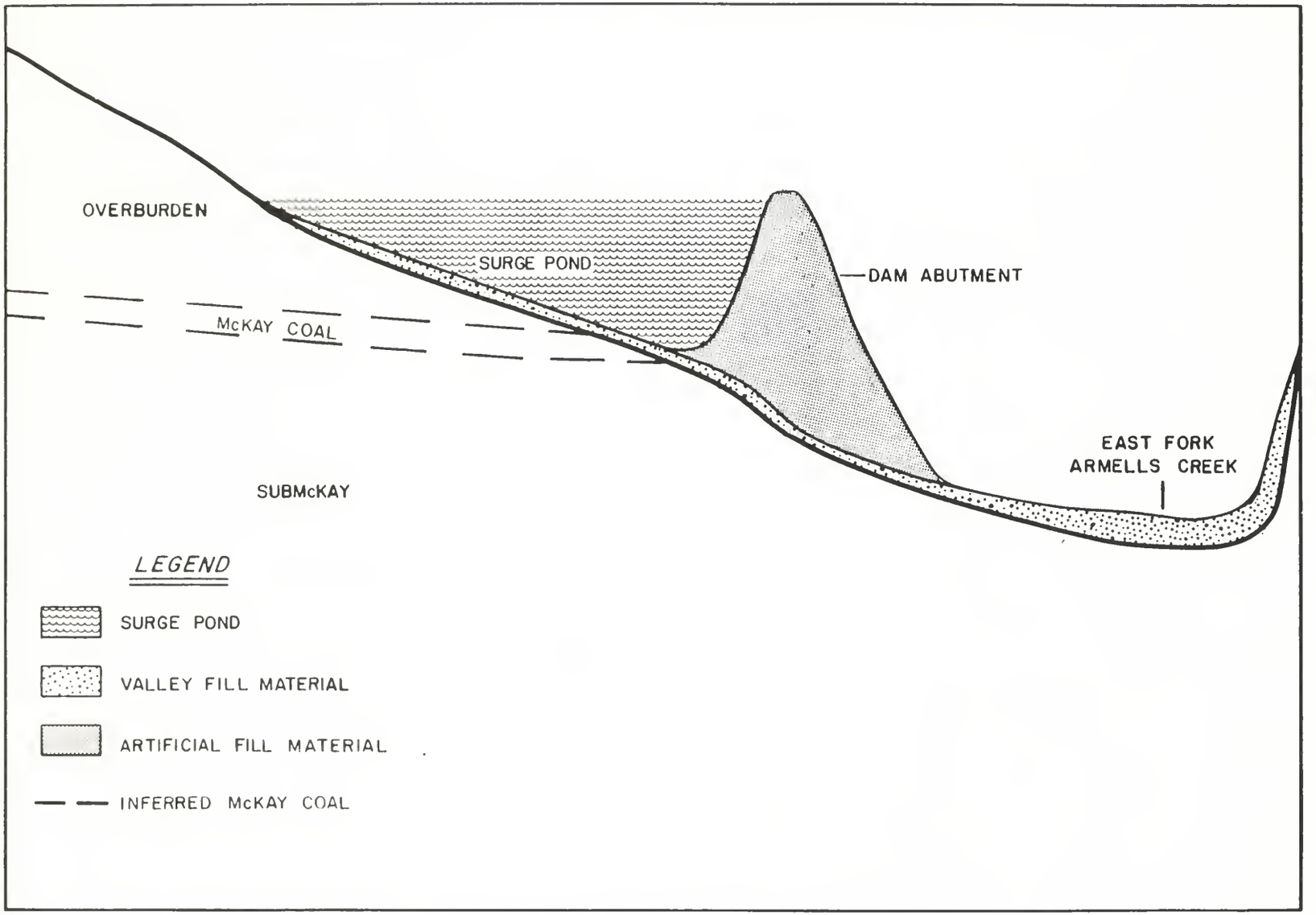


FIGURE II-12 SCHEMATIC WEST-EAST CROSS SECTION ACROSS SURGE POND, ROSEBUD MINE, MONTANA

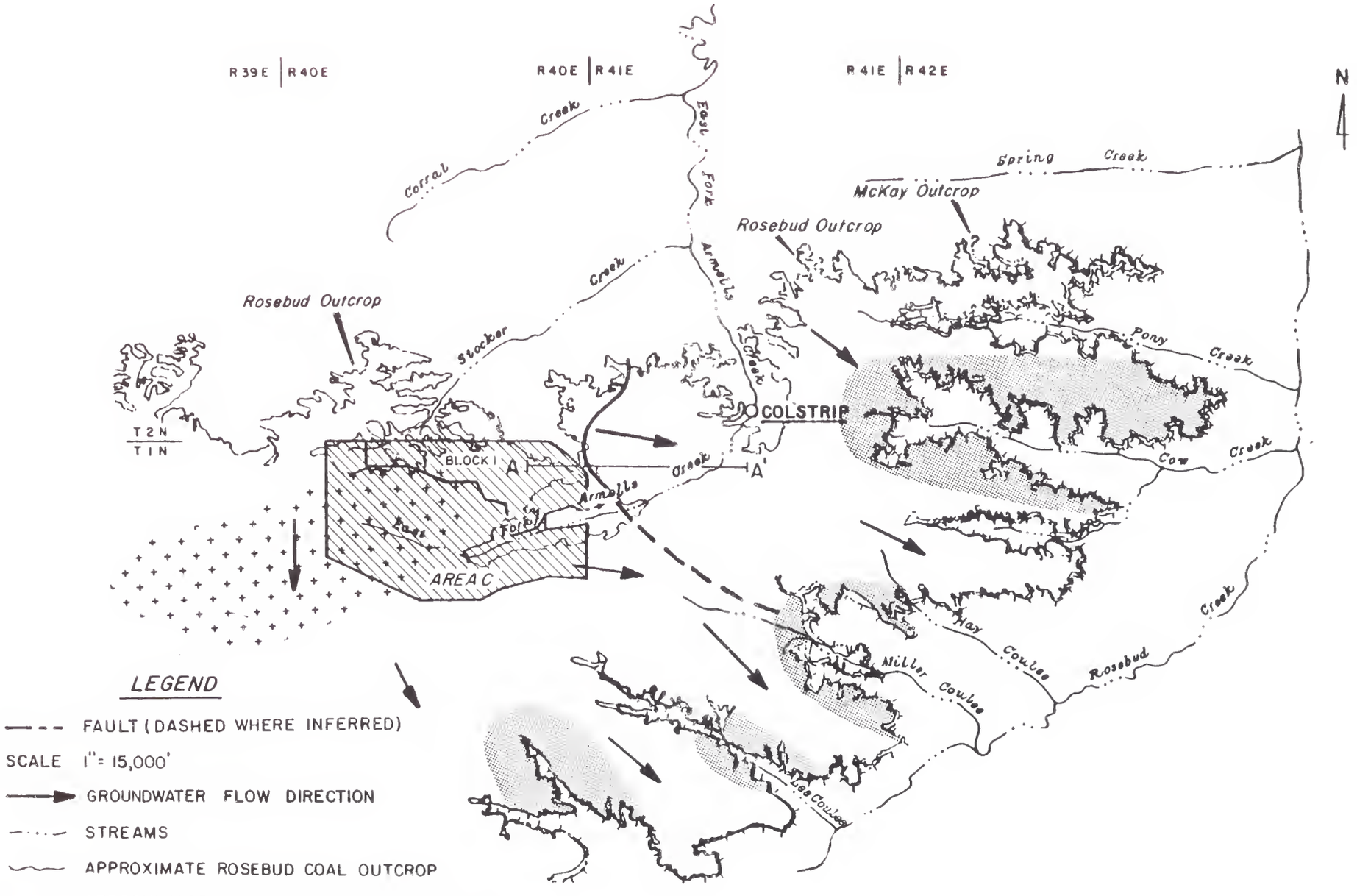


FIGURE II-13 ROSEBUD COAL AND McKAY COAL RECHARGE/DISCHARGE AREAS, ROSEBUD MINE, MONTANA

II-13). The Rosebud and McKay coal seams both outcrop along these coulees, and consequently both aquifers must discharge along these outcrops, contributing to valley fill groundwater flow in each tributary.

There is also an anomalous situation that contributes to stream flow downstream from the Colstrip townsite. Leakage from the surge pond to valley fill and hence to East Fork Armells Creek occurs below Colstrip.

During periods of high streamflow, there is a potential for surface water to recharge valley fill where water may be stored temporarily in valley fill materials. This water would either drain back into the channel or remain as part of the valley fill groundwater, depending upon the groundwater level.

The extent of subirrigation in the valley fill material depends on depth to groundwater, texture of the valley fill material, the type of vegetation, and relationships between ground and surface water. Subirrigation occurs where a combination of groundwater depth and capillary fringe brings water to within 14.5 feet of the ground surface where agricultural plants such as alfalfa can use it. The 14.5-foot depth is considered the maximum depth at which alfalfa can efficiently obtain water for plant maintenance and growth (Dollhopf, 1981). Along East Fork Armells Creek, a capillary fringe of 2.5 feet was estimated, based on averaged textural analyses and discussions with Dr. Doug Dollhopf of Montana State Univeristy. Thus, a depth to groundwater of 17 feet is considered the maximum for subirrigation to occur along East Fork Armells Creek. Figure II-14 illustrates the areas in which, according to the above criteria, subirrigation is known or expected to occur.

5) Summary of Relationships Between Area C, Block I and the Hydrologic Study Area

Throughout the section on groundwater flow, the nature of groundwater movement within the hydrologic study area has been discussed. It is of particular interest to focus on Area C of the hydrologic study area to delineate any aspects of groundwater flow that are considered to be unique with respect to flow in the larger hydrologic study area.

In fact, the groundwater flow system in Area C, Block I is simpler than the larger area. The major characteristics of flow in this area are: 1) Area C serves as a recharge area for the Rosebud and McKay coal seams; 2) groundwater flow is in a south, southeast and easterly direction; and 3) some of the groundwater is discharged to the valley fill along East Fork Armells Creek. Exactly which bedrock unit is contributing flow to valley fill depends upon the reach of the stream (refer to Figure II-11). The course of East Fork Armells Creek through Area C is nearly on strike (normal to the dip of beds), so that as the stream valley floor drops in elevation it contacts deeper strata.

As an area of groundwater recharge, Area C ultimately contributes to flow in tributaries to Rosebud Creek. A paucity of hydraulic and hydrogeologic data specific to Area C, and Area C, Block I precludes a more detailed comparison between groundwater flow in Area C and the study area as a whole.

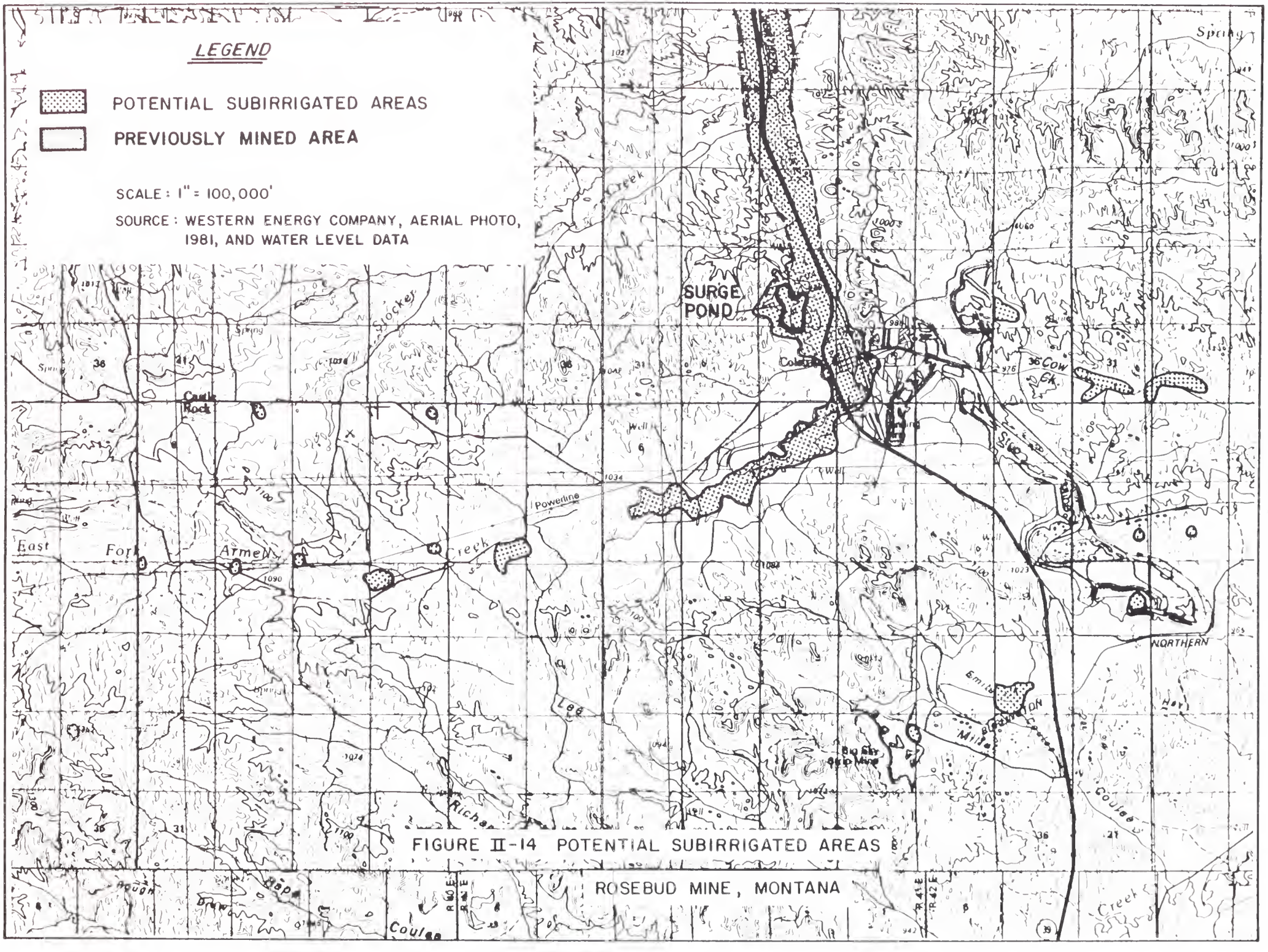


FIGURE II-14 POTENTIAL SUBIRRIGATED AREAS

ROSEBUD MINE, MONTANA

c. Groundwater Quality

Groundwater quality in the Rosebud Mine area is influenced and controlled by geology, climate, and human activities. Geologic materials controlling near-surface water quality are Rosebud spoils, valley fill material, Rosebud coal overburden, Rosebud coal, Rosebud/McKay interburden, and McKay coal. The physical and hydraulic characteristics of each of these water-bearing strata were discussed earlier in Section B.1.a of this chapter.

The influence of climate on water quality in the Rosebud Mine area is generally related to the number, duration, and frequency of precipitation events. Climatic factors are discussed in Section C of Chapter II.

Human activities influencing groundwater quality in the Rosebud Mine area are mining, the MPC electric generating facility, and community activities at Colstrip townsite. The areal extent to which groundwater in the vicinity of the Rosebud Mine has been potentially affected by human activities is depicted in Figure II-15.

The present-day quality of groundwater in Area C has not been affected by human activity.

In the following sections, the existing quality of water in each water-bearing unit is discussed, preceded by a discussion of water quality suitability criteria.

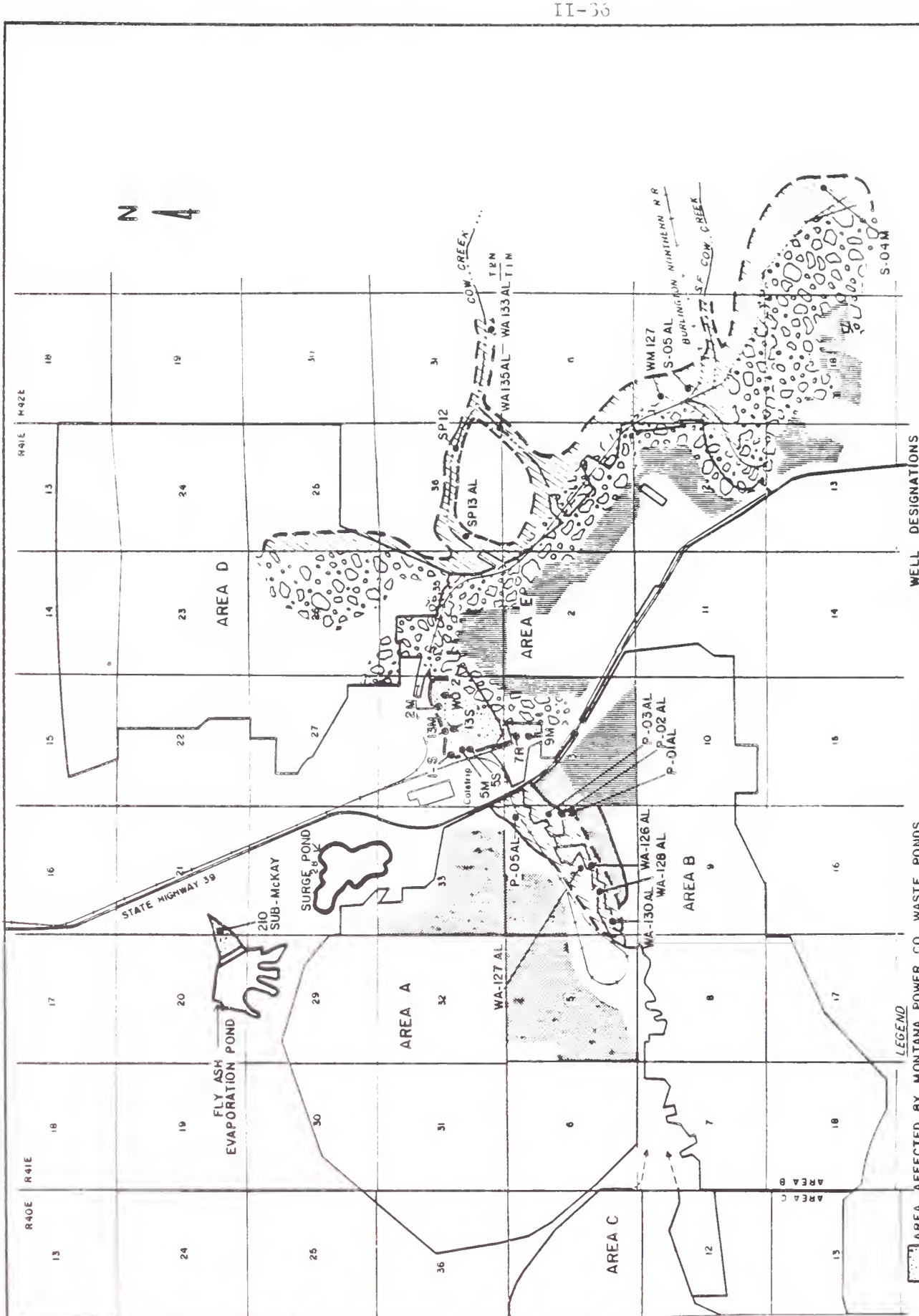
1) Water Quality Suitability

Suitability of waters for irrigation depends to a large extent on factors such as soil type, drainage conditions, management practices, crop type, and on the salinity* hazard* of the water. The classification shown in the following table, as modified from the U.S. Salinity Laboratory Staff (1954), is often used with respect to irrigation water:

Salinity hazard	Range of dissolved solids
Low	Less than 170 mg/l
Medium	170-500 mg/l
High	500-1,500 mg/l
Very High	More than 1,500 mg/l

Raising livestock is an important industry throughout the Rosebud Mine area and stock watering is an important water use. Livestock tolerance to high levels of dissolved solids depends upon the type and age of stock and the period of adjustment to higher levels. Stock water standards for Montana waters (McKee and Wolf, 1971) are shown below:

Category	Range of dissolved solids
Good	Less than 2,500 mg/l
Fair	2,500-3,500 mg/l
Poor	3,500-4,500 mg/l
Unfit	More than 4,500 mg/l



NOTE: EFFECT OF SPOILS BOUNDARY DASHED WHERE INFERRED
WELLS SHOWN HAVE RECORDS WHERE EFFECTS ARE EVIDENT OR SUSPECT
OTHER WELL LOCATIONS SHOWN ON FIGURE II-5

FIGURE II-15 WATER QUALITY MAP SHOWING AREAS AFFECTED AND POTENTIALLY AFFECTED BY HUMAN ACTIVITIES, ROSEBUD MINE AREA

Poultry, pigs, horses, cattle, and sheep (in respective order) have increasing degrees of tolerance to salinity. McKee and Wolf (1971) list the suggested upper limits of dissolved solids concentration for various types of stock as follows:

Livestock	Concentration, in milligrams per liter
Poultry	2,860
Pigs	4,290
Horses	6,430
Cattle (dairy)	7,150
Cattle (beef)	10,100
Sheep (adult)	12,900

Some investigators suggest that these values are much too high for optimal growth and development of livestock. It has also been determined that certain major ions may be more limiting than the sum of all constituents. For example, stock can tolerate higher dissolved solids when the water is a sodium-chloride type (McKee and Wolf, 1971).

Most groundwaters in the Rosebud Mine area and Area C have average TDS concentrations ranging from 1,500 to 2,500 mg/l. The range of concentrations normally varies from 500 to 3,500 mg/l. For livestock use, this range would fit the categories of "fair" to "good," however, as applied to irrigation, the salinity hazard classification indicates that a "very high" hazard exists. The fact that an agricultural economy has been viable in the Rosebud Mine area for many decades demonstrates the adequacy of water quality in this part of Montana.

2) Quality of Water-Bearing Strata

A summary of water quality constituent concentrations for the Rosebud spoils and the other water-bearing strata in the Rosebud Mine area and for Area C is provided in Table 1 of Appendix B, and is detailed in the following sections.

a) Rosebud Spoils

The groundwater that occurs in the spoils generally has higher TDS concentrations than the Rosebud overburden or the Rosebud coal aquifers. Average TDS level in the Rosebud Mine area for 35 spoils wells is 3,300 mg/l, as compared to 1,250 mg/l for 22 wells in the Rosebud overburden aquifer and 1,890 mg/l for 55 wells in the Rosebud aquifer. TDS levels of spoils wells at the Big Sky Mine average 3,400 mg/l.

An increase in calcium, magnesium, sodium, bicarbonate, sulfate, and chloride was recorded for spoils wells, which is generally in proportion to the increases in TDS found in Rosebud overburden and Rosebud coal wells. Concentrations and ranges of individual constituents are presented in Table 1 of Appendix B. The pH* of spoils waters is slightly lower than that of overburden waters, ranging from about 6.8 to 7.8; whereas, the pH for overburden water ranges from 7.2 to 8.4. Iron concentrations are slightly lower; whereas, manganese is slightly higher in spoils waters than in overburden waters. Other trace elements are

comparable in overburden and spoils. Spoils waters fall into a fair-to-poor category for livestock watering.

b) Valley Fill Aquifer

Water quality in the valley fill of the Rosebud Mine area is quite variable, with TDS ranging from about 1,300 to 6,000 mg/l. The average concentration for all wells is about 2,800 mg/l. Highest concentrations, in the range of 3,500 to 6,000 mg/l, are found at random locations and result from natural causes and the impact of mining. The impact of mining operations on valley fill water quality is fairly apparent in the headwaters of Cow Creek and on East Fork Armells Creek. Wells showing evidence of water quality changes are as follows:

Well Number[1]	Maximum TDS Concentration (mg/l)	Area-Location
S-05	6,000	Cow Creek
S-13	4,530	Cow Creek
WA 133	3,930	Cow Creek
WA 135	4,340	Cow Creek
PO-1	2,790	A,B, E. Frk. Armells Crk.
PO-2	2,730	A,B, E. Frk. Armells Crk.
PO-3	2,820	A,B, E. Frk. Armells Crk.
PO-5	5,110	A,B, E. Frk. Armells Crk.

[1] Refer to Figure II-5 for well locations

Table 2 of Appendix B shows data documenting changes in TDS concentrations with time for wells S-05, S-13, P-01, P-02, P-03, and P-05. Table 3 of Appendix B compares TDS concentrations of wells WA-133 and WA-135, with TDS concentrations of other valley fill wells in Cow Creek and Pony Creek basins east of the Northern Pacific mined area.

Water quality in the Area C valley fill has not been impacted by mining and is more variable than that of other undisturbed areas. TDS concentrations range from 1,390 mg/l in well WA-103 (Figure II-5) to 4,680 mg/l in well WA-121 (Figure II-5). Higher concentrations are found toward the western end of the area and in Stocker Creek headwaters, where concentrations are predominantly in the range of 2,000 to 4,000 mg/l. In the eastern portion of Area C and in the mid-reach of Stocker Creek, concentrations range from about 1,500 to 2,000 mg/l. The water is a magnesium sulfate type with hardness*, ranging from 837 to 2,430 mg/l.

Trace element and nutrient levels are at or near detection levels, which are well below drinking water standards, and should present no problems. All waters should be suitable for stock watering, the primary use in this area.

c) Rosebud Coal Overburden

Analyses of water from three wells, WO-101, WO-103, and S-23 (located on Figure II-5) drilled in the overburden in Area C show that TDS

levels range from 400 to 2,500 mg/l. The overburden well nearest to Area C, Block I is located at the western extremity of Block I and has a TDS level of 2,410 mg/l. Chemical data from overburden wells in Area C are not sufficient for statistical comparison; however, the data are similar to data collected in Area B, which are sufficient for statistical analysis. TDS concentrations in Area B range from 600 to 2,500 mg/l, and average 1,850 mg/l. These concentrations have been used as reasonable estimates of water quality in the overburden in Area C.

d) Rosebud Coal

Some of the best quality groundwater in the Rosebud Mine area is found in the Rosebud coal aquifer (Table 1, Appendix B). TDS concentrations range from 400 to 6,500 mg/l; however, the majority of water samples had TDS concentrations in the range of 400 to 1,500 mg/l. Only three wells have concentrations greater than 3,000 mg/l in the Rosebud Mine area, two of which are located in the headwater area of East Fork Armells Creek and Stocker Creek in Area C (wells WR-103 and WR-121 on Figure II-5). The high concentrations in the western portion of Area C may be due to a higher clay and shale content in the overburden and to numerous faults, which have produced solution zones allowing deeper-seated, more mineralized waters to migrate upward into the Rosebud coal aquifer.

The three wells drilled in Area C, Block I have the following TDS concentrations: WR-122 - 534 mg/l; WR-117 - 459 mg/l; and WR-126 - 2,260 mg/l (Figure II-5). Well WR-126 is located along the outcrop of the Rosebud coal, where mineralization from the overlying shale and surface weathering are considered responsible for the higher concentration. Much of the water underlying Block I is probably similar in quality to that of wells WR-117, WR-122, and WR-126.

e) Interburden Aquifer

The predominant range of TDS for all interburden wells in the Rosebud Mine area is 1,500 to 3,000 mg/l. TDS concentration for the Rosebud Mine area ranges from 684 to 3,500 mg/l. There is no direct evidence in the Rosebud Mine area that waters from spoils have contaminated or penetrated the interburden aquifer; however, power plant wastes appear to have caused an increase in TDS in the interburden aquifer near the townsite of Colstrip and at fly ash pond 210, located about two miles northwest of Colstrip (see discussion in next subsection on McKay coal). In 1980, water in some wells located below or near industrial ponds had TDS concentrations as high as 8,000 to 9,000 mg/l. Pre-mining levels were probably in the range of 500 to 3,500 mg/l (Botz, 1978).

Two wells, WI-100 and WI-104 (Figure II-5), located in the vicinity of Area C, Block I, have TDS concentrations of 1,655 and 2,700 mg/l, respectively. Concentrations of TDS for two interburden wells (WI-100 and WI-104) are probably typical of the range of concentrations for interburden aquifer water in Area C. The water can be characterized as calcium sulfate or magnesium sulfate water, depending on well location. Calcium and magnesium TDS concentrations are generally in the range of 100 to 200 mg/l. Sodium concentrations typically range from 100 to 300

mg/l; however, because of faulting in the area and the suspected upward migration of deeper waters, it is probable that sodium sulfate waters are present in the interburden of Area C. In that case, sodium concentrations in these areas could be similar to that found in the sub-McKay, which has a sodium concentration as high as 700 mg/l.

f) McKay Coal

Two types of water are found in the McKay aquifer: a magnesium-sulfate and a sodium-sulfate type. Magnesium-sulfate water is found in most of Areas B and E, in the eastern and western portion of Area C, and in parts of Area D. Sodium sulfate waters are present in the central portion of Area C, in the northern portion of Area A, in Area D, and in one well at the Big Sky Mine. It is postulated that the sodium-type water is fault or coal flexure* controlled and results from upward migration of water along fracture zones from the sub-McKay aquifer or below, where such waters predominate.

The sodium-sulfate type water has calcium, magnesium, and sodium concentrations in the range of 15 to 100 mg/l, 6 to 75 mg/l, and 200 to 800 mg/l, respectively. Magnesium-sulfate type water has calcium, magnesium, and sodium concentrations in the range of 150 to 250 mg/l, 100 to 150 mg/l, and 100 to 200 mg/l, respectively. Bicarbonate and sulfate concentrations are similar to those found in all waters of the area: sulfate predominates, with a range of 200 to 1,500 mg/l, and bicarbonate varies from about 400 to 600 mg/l. Trace element concentrations are at or near detection levels.

Except where affected by spoils water, TDS concentrations range from about 500 to 2,500 mg/l. The description and concentration range cited above generally fits the situation in the Rosebud Mine area except for Area E, where wells S-04, S-08, and WM-127 (Figure II-5) have increased in TDS with time and have average concentrations of 5,725, 3,192, and 7,455 mg/l respectively (see Table 4 of Appendix B). The increase in TDS concentration over time indicates an external source of the salinity. The cyclic variation evident in well S-04 demonstrates the influence of precipitation on the recharge to wells and on the dissolved solids content. That is, wet years produce more recharge and usually lower salt concentrations than dry years. The time when these changes occur is dependent upon the amount of recharge from precipitation, the transmissivity of the aquifer, and the distance from the recharge area. This cyclic effect on TDS can be noted in data from other wells with sufficiently long periods of record.

g) Sub-McKay Aquifer

The majority of waters in the sub-McKay are of the sodium-sulfate type in the Rosebud Mine area. Water quality data is available for two wells in Area C, WD-101 and WD-102 (Figure II-5). Well WD-101 has water of a sodium-sulfate type and WD-102 yields magnesium-sulfate type water. Based on inspection of water quality in the McKay aquifer of Area C and the prevalence of faulting, one would expect the predominant water type in the sub-McKay to be of the sodium-sulfate type. TDS concentrations in the sub-McKay waters of the Rosebud Mine area generally occur

within the range of 1,000 to 3,000 mg/l. The only sub-McKay well in the Rosebud Mine area where some contamination is indicated is well 5-S (see Figure II-5), located adjacent to pond 951 at the Montana Power Company generating station in Colstrip, where TDS in December 1980 was 8,500 mg/l.

d. Groundwater Use

Groundwater withdrawn from the water-bearing strata in the Rosebud Mine area is primarily used for livestock. A few wells are also used for domestic water supply. Based on data presented by Van Voast (1977), approximately 36 percent of the domestic and stock wells are completed in the sub-McKay aquifer. The sub-McKay aquifer appears to be the most dependable water source because most of the wells in the study area are completed in this formation. Of the remaining stock water and domestic wells in the area, 30 percent are completed in the Rosebud overburden, ten percent are completed in the Rosebud coal, and less than ten percent are completed in the valley fill and McKay coal. Sixteen percent of the recorded wells in the study are either completed in other aquifers or well records cannot be located.

The McKay coal aquifer is rarely used as a water source because of its low productivity.

Ephemeral* springs are also used for livestock watering. Table B1-3 in the Technical Support Document lists the springs located in the hydrologic study area, while Plate B-2 illustrates their locations. Specific information on private wells and groundwater rights can also be found in the Technical Support Document (Tables B1-1 and B1-2, and Plate B-2).

2. Surface Water

The proposed Area C, Block I permit area is 4.5 square miles ($mi.^2$) (or 2,877 acres), and straddles the watershed divide between East Fork Armells Creek and Stocker Creek. Stocker Creek, with a drainage area of 26.1 $mi.^2$, flows into East Fork Armells Creek about three miles north of the Colstrip townsite. At the confluence of these two streams, the total drainage area is approximately 73.8 $mi.^2$. A total of 1,646 acres (2.6 $mi.^2$) of the permit area lies within the Stocker Creek drainage, and 1,231 acres (1.9 $mi.^2$) lay within the East Fork Armells Creek drainage (Figure II-16).

a. Drainage Basin Characteristics

East Fork Armells and Stocker Creeks both reflect the influence of bedrock and structural control. This influence is strongest in the headwaters of these creeks and decreases downstream, although some bedrock control of East Fork Armells Creek may continue throughout Area C. The areal extent of valley fill in both basins generally increases downstream, so that the main streams of East Fork Armells Creek and Stocker Creek flow within alluvial channels. The small, ephemeral* tributaries, however, are developed primarily on bedrock throughout the permit area.

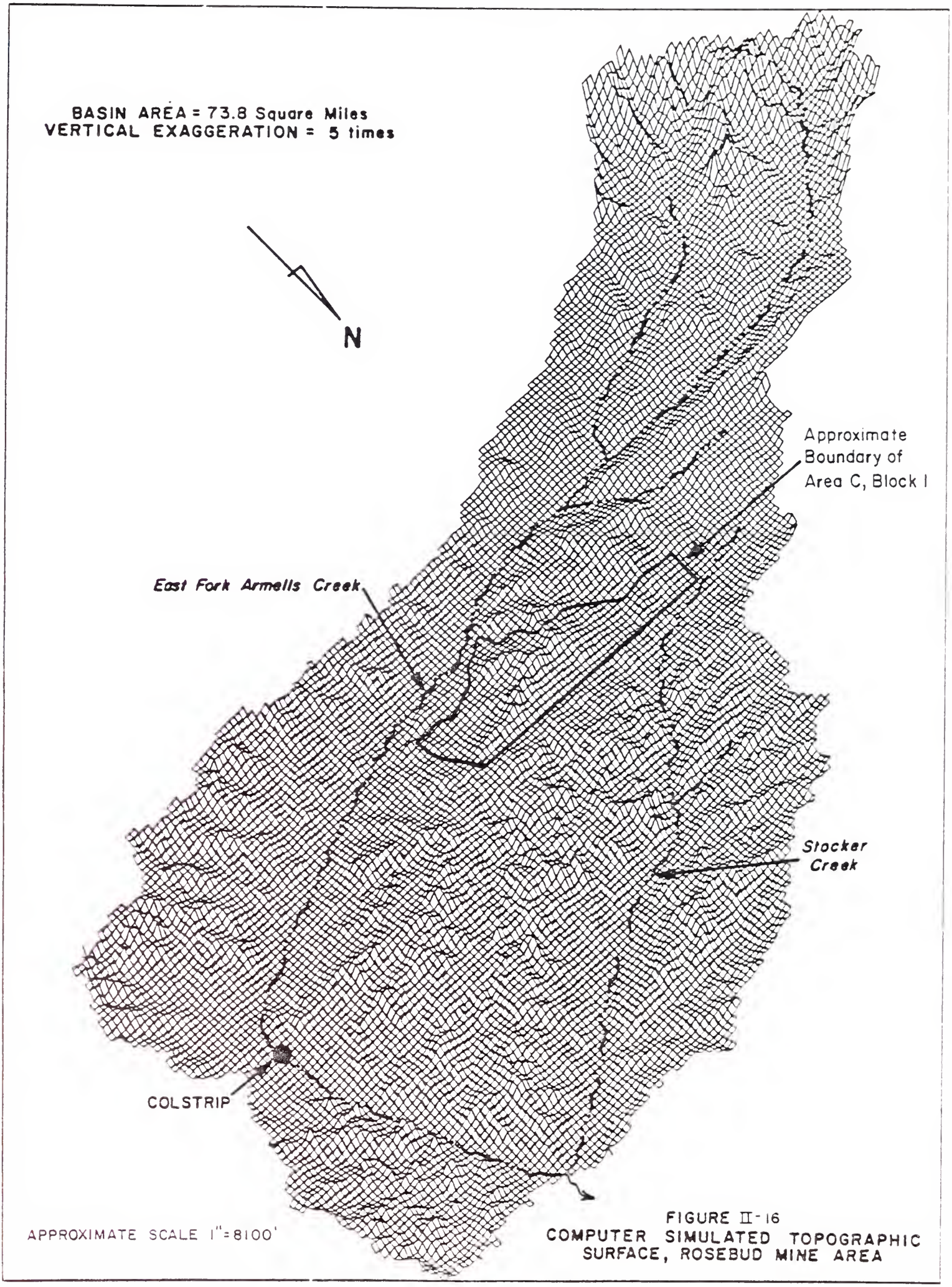


FIGURE II-16
COMPUTER SIMULATED TOPOGRAPHIC SURFACE, ROSEBUD MINE AREA

Analysis of the drainage networks suggests that they are in equilibrium, where a relative balance between stream energy and transport exists. Both the main channels and tributaries of East Fork Armells Creek and Stocker Creek are entrenched, vegetated, and appear to be stable. Major entrenchment of the main streams of the basins is related to climatic change and base level* lowering since the Pleistocene Epoch. The stream network characteristics indicate that the tributary channels have generally adjusted to such long-term changes.

b. Stream Channel Characteristics

Through Area C, the main stem of East Fork Armells Creek is an alluvial channel, with sinuosities* ranging from 1.56 to 2.37, which increase progressively downstream. The longitudinal profile of the creek channel is concave and shows no clear evidence of current instability, neither as major slope changes nor as knickpoints*. In contrast, the ephemeral channels developed on the hill slopes of the upland areas have much straighter longitudinal profiles. Detailed surveys of 12 ephemeral channels in Area C (Appendix O, Western Energy Company Area C, Block I, Application for Surface Mining Permit) indicate that channel oversteepening due to deposition, followed by channel entrenchment, is common in these channels. Deposition and incision are also occurring in response to a change in base level from dam construction.

c. Drainage Basin Sediment Yields* and Landscape Stability

Calculations by Ertec, Inc. (see Section B.4 of the Technical Support Document) estimate that sediment yields within Area C are relatively low, ranging from 0.11 to 0.29 acre-feet per square mile per year, and are significantly below average basin yields, which range from 0.3 to 1.0 acre-feet per square mile per year that have been measured under similar geologic conditions in the High Plains region (e.g. Schumm and Lichty, 1965; Ringen et al., 1970). This reflects the predominance of landscape units (sediment source areas) with low or moderate sediment yields and the inefficiency of the vegetated ephemeral stream channels in transporting sediment.

The results of the geomorphic studies summarized above indicate that over relatively large areas (the scale of the East Fork Armells and Stocker Creeks drainage basins) and a long time frame of several hundred years, the landforms and drainage networks within Area C appear to be stable under existing environmental conditions. There is no evidence of widespread accelerated erosion. The major stream channels, although commonly entrenched, are vegetated and do not appear to be undergoing active gullying. However, at the scale of the small ephemeral drainages within Area C, there is some evidence (Technical Support Document, Section B.4) to suggest that these channels are inherently unstable.

d. Surface Water Flows

East Fork Armells Creek and Stocker Creek are intermittent* streams in Area C that flow in response to local and regional groundwater inflow over short reaches, as well as for short time periods in response to

snowmelt and high-intensity precipitation events. The proposed permit area is drained by 14 ephemeral drainages tributary to East Fork Armells Creek and Stocker Creek. These tributaries also flow in response to late winter and early spring snowmelt and to late spring and early summer high-intensity precipitation events. Estimates of average annual discharges of 0.08 inches per year have been made by Van Voast (1977). This is equivalent to 315 acre-feet per year at the confluence of Stocker Creek and East Fork Armells Creek. Low flow in both drainages is zero. Although surface water gaging stations exist in the area (Appendix B, Table 5), flow records for Stocker Creek and East Fork Armells Creek are insufficient to accurately describe the magnitude and frequency of floods. However, techniques described by Parrett and Omang (1981) can be applied for estimating flood flows for the 2-, 5-, 10-, 25-, 50-, and 100-year floods. Estimates of flood peaks for Stocker Creek and East Fork Armells Creek are shown in Tables II-4 and II-5, respectively.

USGS continuous flow records for nearby areas were investigated for flow duration statistics. A relationship of the probability of flow occurrence per square mile of drainage area (Appendix B, Figure 1) was computed using these flow duration statistics. The computations demonstrated a close relationship between each stream, indicating a similarity of flow characteristics in the basins (Table II-6). This relationship was used to estimate flow statistics and to synthesize a probability of flow occurrence curve for East Fork Armells Creek below the confluence with Stocker Creek. The synthesized curve (Appendix B, Figure 2) indicates that for 90 percent of the days investigated, flow would be less than 2.5 cfs; for 80 percent of the days flow would be less than 1.0 cfs; and for 40 percent of the days, flow would be less than 0.01 cfs (essentially no flow). This curve illustrates that East Fork Armells Creek below the confluence with Stocker Creek has little or no natural base flow*.

e. Surface Water Quality

1) Streams

The proposed mining in Area C, Block I will occur in Sections 1, 2, 3, 4, 11, and 12 of T1N, R40E. The study area crosses the drainage divide between the north side tributaries of East Fork Armells Creek and the headwater areas of several tributaries on the south side of Stocker Creek. All tributaries in the area are ephemeral and dry for much of the year, flowing only in response to snowmelt and storm runoff (Surface Water Section 2.d). Data from surrounding areas on East Fork Armells and Stocker Creeks have been collected by Western Energy for a sufficient period of time and in a range of conditions to permit an adequate assessment of surface water quality. These data are used to supplement longer term data collected by the USGS on several streams in the area. Records of complete chemical data collected on almost a monthly basis by the USGS are as follows:

Location	Period of Record
East Fork Armells Creek near Colstrip	January 1975 to May 1981
East Fork Armells Creek near Forsyth	October 1974 to October 1981

TABLE II-4

FLOOD MAGNITUDE CALCULATIONS
FOR STOCKER CREEK AT MOUTH

Drainage Area (sq. miles): 26.11

Area Code: 4; Southeast Plains Region

Percent Forest Cover: 10.8

Geographic Factor: 0.8

Recurrence Interval	Flood Magnitude[1] (Cubic Feet per Second)
2	101
5	266
10	415
25	667
50	933
100	1,240

[1]Parrett and Omang, 1981

TABLE II-5

FLOOD MAGNITUDE CALCULATIONS
FOR EAST FORK ARMELLS CREEK
AT CONFLUENCE WITH STOCKER CREEK

Drainage Area (sq. miles): 47.7

Area Code: 4; Southeast Plains Region

Percent Forest Cover: 10.7

Geographic Factor: 0.8

Recurrence Interval	Flood Magnitude[1] (Cubic Feet per Second)
2	145
5	379
10	584
25	928
50	1,300
100	1,720

[1]Parrett and Omang, 1981

TABLE II-6

FLOW STATISTICS FOR SELECTED STREAMS
ROSEBUD MINE AREA

USGS Gage Number	Stream	Period of Record (Water Year)	Flow (cfs) Mean	Median	Mode	Range
062941940	Sarpy Creek near Hysham ($453\ mi^2$)	1974 through 1980 (7 years)	8.3	1.3	5.0	0-390
06294690	Tullock Creek near Bighorn ($446\ mi^2$)	1975 through 1980 (6 years)	12.3	1.1	5.0	0-1110
06294995	Armells Creek near Forsyth ($370\ mi^2$)	1975 through 1980 (6 years)	8.1	0.46	5.0	0-750
---[1]	East Fork Armells Creek ($73.8\ mi^2$)	---	1.5	0.13	---	---

[1]These flows were derived from the other recorded flows in this table.

West Fork Armells Creek near Forsyth	November 1974 to June 1977
Rosebud Creek Near Colstrip	October 1974 to October 1981
Rosebud Creek above Pony Creek near Colstrip	October 1974 to November 1977
Cow Creek near Colstrip	October 1979 to May 1981

Concentrations of dissolved constituents are highly variable with respect to time in the East Fork Armells Creek and Stocker Creek basins in response to surface runoff events that dissolve minerals from the land surface. Discharge of subsurface water from valley fill, overburden, and possibly the Rosebud aquifer also influence stream quality. TDS concentrations range from about 200 mg/l at highest flows to about 6,500 mg/l at low base flow. TDS concentrations generally are in the range of 3,000 to 4,500 mg/l since low flows prevail for most of the year. Table 6, Appendix B lists TDS for samples collected by USGS for several sites in the Colstrip area. Stream discharge of the East Fork Armells Creek at Colstrip is also provided to show the relationship between conditions in the area at the time of sampling. Highest TDS concentrations in the range of 4,500 to 5,000 mg/l frequently occur during extreme low flow as a result of concentration from evaporation, transpiration, and biological activity as water passes slowly through pools along several reaches of the stream. These concentrations usually exceed those found in groundwaters of the valley fill and Rosebud aquifers along stream channels by 200 to 300 percent. Valley fill is the predominant source of recharge to streams at low flow, with water also contributed from the Rosebud aquifer in some areas (Groundwater Flow Section, Section 1.C).

Several areas in the East Fork Armells Creek drainage basin appear to have slightly higher TDS concentrations than those found in other stream segments in the Rosebud Mine area, and are presumed to be due to geologic differences. These areas are located approximately as follows: (a) the western half of Area C; and (b) the upper half of Stocker Creek basin (refer to Figure II-3). The evidence for these higher concentrations comes through an inspection of the data collected at surface water site SW-09 in the headwaters of East Fork Armells Creek, about one mile southwest of Area C, Block I; and from site SW-65 on Stocker Creek, about one mile northwest of the northwest of Area C, Block I. Data for West Fork Armells (SW-09 and SW-65, see Figure II-5) are provided in Table 7 of Appendix B. The soils in these areas contain higher proportionate amounts of clays and shales, which contain more soluble minerals than the sandy materials found in the remaining area (see discussions on Geology and Soils, Sections A and F). The surface waters of upper East Fork Armells Creek and Stocker Creek are very hard and have a very high salinity hazard most of the time, with TDS concentrations usually above 2,500 mg/l.

The surface waters in the Rosebud Mine area are a magnesium-sulfate type, with magnesium concentrations usually in the range of 200 to 500 mg/l and sulfate ranging from 1,500 to 3,000 mg/l. Calcium ranges from 200 to 300 mg/l, and sodium from 200 to 400 mg/l; bicarbonate concentrations are usually 400 to 550 mg/l. The relationships between TDS and

specific conductance and between specific conductance and calcium, magnesium, sodium, and bicarbonate and sulfate for East Fork Armells Creek near Colstrip are shown in Figure 3, Appendix B.

The quality of water in the reach of East Fork Armells Creek upstream of Colstrip is quite similar to that shown on Figure 3 in Appendix B. Concentrations occurred at the high end of the range about 80 percent of the time. Sodium, magnesium, and sulfate constituents have a linear relationship with TDS at all levels; whereas, calcium and bicarbonate at these high levels reach a plateau, indicating saturation. The water is alkaline with pH in the range of 7.5 to 8.3. Nitrogen and phosphorus are usually low, with concentrations of a few tenths to a few hundredths milligram per liter, respectively. Fluoride concentration is generally 0.1 to 0.2 mg/l.

Trace metal concentrations are at or near the detection level of analytical methodology and constitute no problem, except for mercury concentrations found at several sampling points. For example, samples collected at SW-09, located about one mile southwest of Area C, Block 1, had mercury concentrations of 0.030 and 0.040 mg/l on several occasions. These values exceed the primary drinking water standard, and are believed to be inaccurate; probably resulting from sampling and/or laboratory error.

2) Ponds

The quality of water in ponds in the Rosebud Mine area that receive runoff from disturbed and reclaimed areas of strip mined lands is similar to that contained in the streams of the area. During spring runoff, concentrations will range from about 300 mg/l upward to about 2,000 mg/l. During summer and fall months, concentrations from about 2,000 to 4,000 mg/l will occur as a result of concentration from evaporation and possibly inflow from subsurface drainage. However, the latter is not considered to be a major factor. These concentrations are in a range suitable for stock watering purposes.

Several farm ponds in the area have water quality similar to that found in mining areas, except during late summer and fall they become slightly more concentrated, possibly due to farm activities or increased evapotranspiration rates.

3) Springs

Five springs are located in the Stocker Creek drainage of Area C. Two springs, SP-05 and SP-03 (Figure II-5), are located in Stocker Creek valley fill. The water is highly mineralized, with TDS concentrations of 5,160 and 4,930 mg/l. The remaining three springs (SP-01, SP-02, and SP-04 in Figure II-5) are located along the northern boundary of the Rosebud outcrop in the eastern portion of Area C. SP-01 is similar to the valley fill springs in concentration with TDS of 5,310 mg/l. Spring SP-04 has a TDS of 3,240 mg/l and spring SP-02 is of relatively good quality, with TDS of 470 mg/l. Chemical data on quality of springs is contained in Table 8 of Appendix B.

The nitrate (NO_3) concentration of spring SP-02 far exceeds the normal for waters in the area, and probably results from organic material such as livestock wastes. Trace metal concentrations were at or below analytical detection levels, except for mercury in springs SP-01 and SP-04, which were 0.230 and 0.010 mg/l, respectively.

f. Surface Water Use

Surface water in East Fork Armells Creek is used for stock water and for flood irrigation downstream of Colstrip. There is no municipal, commercial, or irrigation use of surface water in the East Fork Armells Creek in the immediate vicinity of Colstrip townsite or the Rosebud Mine area. Stocker Creek surface flows are used for stock watering only.

Water is imported via a 29-mile pipeline from the Yellowstone River at a potential maximum rate of 10,000 gallons per minute, for municipal and commercial use by the town of Colstrip, mining activities, and the Montana Power Company power plant. A 112-acre surge pond with a capacity of 2,250 acre-feet stores this imported water. Seepage rates from the surge pond are estimated to range from 175 acre-feet per year (Technical Support Document, Section B.1), to 180 acre-feet per year (Hydrometrics, 1981), indicating that the pond may be causing a rise in the local water table, which may have effects downstream of the surge pond.

The MPC power plant complex uses approximately 90 to 95 percent (or 7,700 acre-feet) of surge pond water per year. Approximately 85 percent of the water used at the power plant is lost to the atmosphere through evaporation from cooling processes and pond surfaces, some water is lost from pond seepage, and the balance is used mostly for road watering for dust suppression. During the months of March through October, current mine water use for dust suppression amounts to approximately 400 acre-feet of water. Most of this water is lost to the atmosphere through evaporation.

Municipal water use at Colstrip townsite is approximately 630 acre-feet of surge pond water per year, given the present (1980) population. Large amounts of this water are used during the summer months for household and community irrigation. Wastewaters from aproximately 1,150 housing units in Colstrip are treated and released into East Fork Armells Creek (Hydrometrics, 1981). The treated discharge ranges from 17 acre-feet per month to 23 acre-feet per month. This discharge is an additional potential contributing factor to a rise in the local water table, and may also have downstream effects.

3. Hydrologic Budget

The hydrologic budget quantitatively defines inflow and outflow water and changes in storage within a specific hydrologic system.

The major components that will be discussed are:

- o Precipitation (rain and snow)
- o The role of vegetation in the hydrologic budget
- o Evaporation from surface water sources
- o Infiltration rates into the soil
- o Soil-water budget
- o Groundwater recharge
- o Groundwater discharge

Other elements in the hydrologic budget, including surface runoff and groundwater flow, are discussed in Sections 1 and 2, respectively, of this EIS. In each component, both existing conditions and post-mining impacts will be addressed as presented by Western Energy in:

- o Area C Permit Application (26.4.314)
- o Comprehensive Mine Plan

a. Precipitation

The Colstrip area is influenced by a Continental-type climate, characterized by a wide range of average seasonal temperatures. The average annual precipitation at the Colstrip National Weather Service (NWS) station is 15.8 inches (Bison Engineering, 1981). Annual precipitation may deviate substantially from this long-term average, and the standard deviation of precipitation totals for the period 1928 to 1977 is 3.5. The extremes in total annual precipitation for the period 1970 to 1980 were 22.12 inches in 1978 and 7.66 inches in 1980.

Approximately 12 inches of this precipitation falls during the April to September growing season, with April, May, and June the wettest months. Summer precipitation occurs as showers and high-intensity thunderstorms.

From November to April, precipitation occurs predominantly in the form of snow. Due to the prevailing westerly winds, snow typically accumulates on the leeward (east) slopes of north-south oriented drainages and shallow depressions. These areas are potential sites of groundwater recharge when snowmelt occurs.

Little information is available on variations in precipitation that occur with topography. However, due to the prevailing westerly winds, it is anticipated that more precipitation will occur on the westerly slopes of the upland areas, particularly in the areas of more extreme relief to the west of the Colstrip study area.

b. The Role of Vegetation in the Hydrologic Budget

The analysis of the hydrologic budget includes an assessment of the influence of vegetation (through its control over the rate at which evapotranspiration occurs). Since actual measurements have not been made, results of pan evaporation studies and of calculations using a modified Blaney-Criddle formula (Soil Conservation Service, 1970) have been used as independent methods to calculate potential evaporation and evapotranspiration losses (see Technical Support Document, Section B.3).

This rate is normally expressed by the potential evapotranspiration, but with a plant cover, this value can be modified with a factor that varies with the type of plant, the stage of plant growth, the development of leaves, and the density of the plant cover. The factors were applied to the measured pan evaporation of 53 inches per year (Technical Support Document, Section B.3), suggesting that potential evapotranspiration from grassland in the Colstrip area is in the range of 36 to 45 inches per year (Dollhopf, 1980; Gray, 1970). Monthly values for these estimates are presented in Table II-7.

The results of the Blaney-Criddle analysis and the balance of monthly precipitation and evapotranspiration are presented in Table II-8. Both this method and the pan evaporation study illustrate that evapotranspiration is highly significant in the water balance of the area.

An additional, although less significant, role of vegetation is the interception of precipitation by vegetation and its subsequent loss by evaporation. No actual measurements of this mechanism exist; however, as part of the water budget analysis made by Western Energy in the Area C Permit Application (26.4.314), the interception of rainfall by grasses in the Colstrip area has been estimated using a relationship developed by Horton (1919). Unfortunately, this empirical relationship is appropriate only for individual storm events and is therefore difficult to apply on an average basis. Results of Western Energy's average monthly interception calculations are discussed in the Area C Permit Application (pages 349 through 351). The total yearly value for the interception of rainfall was estimated to be approximately 0.5 inch per year.

c. Evaporation from Surface Water Sources

Evaporation from surface water sources, such as ponds and reservoirs, can be estimated from Class A pan evaporation data. The results of various studies of pan evaporation data are discussed in the Technical Support Document, Section B.3. These studies indicate that surface water evaporation can range from 33 to 53 inches per year.

d. Infiltration

Infiltration rates for soils in Area C have been estimated from soil surveys conducted by Western Energy as part of the mine permit application (26.4.314, p. 356-358). Most soils in the proposed mining area have a fine loam texture. Infiltration rates for this group range from slow (0.06 inch per hour) to moderately rapid (6 inches per hour).

e. Soil Moisture Budget and Deep Percolation

A major consideration in the water budget of the Colstrip area is whether any of the surface moisture received from precipitation will reach the groundwater table.

An analysis of properties of the major soil groups in Area C indicates that little, if any, water is contributed to the groundwater from

TABLE II-7

ESTIMATED POTENTIAL EVAPOTRANSPIRATION DERIVED FROM COLSTRIP PAN EVAPORATION DATA, 1979. (INCHES)

Location	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
PET (Pan Coefficient 0.68)[1]	--	--	2.02	2.30	5.48	6.12	8.09	6.81	5.34	--	--	--	36.16
PET (Pan Coefficient 0.85)[2]	--	--	2.53	2.87	6.85	7.65	10.11	8.52	6.67	--	--	--	45.20

Pan Coefficient Sources:

[1] Gray (1970, p. 3.44)

[2] Dollhopf (1981)

TABLE II-8

MONTHLY PRECIPITATION AND ESTIMATED POTENTIAL EVAPOTRANSPIRATION BALANCE (BLANEY - CRIDDLE) AT COLSTRIP, MONTANA

Month	Precipitation[1] (Inches)	Potential[2] Evapotranspiration (Inches)	Balance (Inches)
January	0.56	--	+0.56
February	0.56	--	+0.56
March	0.74	—	+0.74
April	1.86	—	+1.86
May	2.47	-3.29	- .82
June	3.31	-4.83	-1.52
July	1.18	-6.70	-5.52
August	1.39	-5.69	-4.30
September	1.38	-3.16	-1.78
October	1.04	-1.53	-0.49
November	0.67	—	+0.67
December	0.63	—	+0.63
Annual Total	+15.79	-25.20	-9.41

(1) Monthly Mean Temp: 1941 - 1970

(2) Calculated using Modified Blaney-Criddle Formula (Soil Conservation Service, 1970)

these soils (see Technical Document, Section B.3). The soils with the greatest potential for recharge under realistic field conditions appear to be the clinker residual soils (Technical Support Document, Section B.4). Also, in areas where water can accumulate (such as small depressions, ponds, and channel bottoms) sufficient moisture may be available to allow significant infiltration into the subsurface.

f. Groundwater Recharge

Water flow in ephemeral stream channels in the Colstrip area is characterized by the passage of well-defined peak flows, often of only a few hours duration in the summer season, separated by long periods without flow. As a consequence, groundwater recharge is relatively low, both in the channels and on the hillslopes. Infiltration (or transmission loss*) into the groundwater reservoir formed by the valley fill material is controlled by hydraulic gradient*, hydraulic conductivity of the aquifer, and hydraulic conductivity of the stream bed.

No direct observations of infiltration or transmission losses of streamflow are available in the Colstrip area. However, measurements in other semiarid areas indicate that the volumes lost to valley fill aquifers may be large. Keepel and Renard (1962), for example, observed that 50 percent of the maximum stream discharge was lost and total flow volume was reduced by 35 percent over a 10-mile stream reach. Turner et al. (1943) stated that infiltration losses of 75 percent in 15 to 25 miles were common. In perennial channels, a study of 57 flood events on 18 rivers in the Great Plains revealed an average loss of 40 percent on channel lengths of 50 miles, with as much as 75 percent of the flood volume being lost.

The relative importance of transmission losses is obviously related to the inflow volume, at least up to some level of discharge because of the characteristics of the channel cross section. Where the width/depth ratio of a channel is large (that is, where a small increase in flow depth will yield large increases in stream width), the consequent increase in surface area covered by water will also increase transmission loss. Many of the streams of the Colstrip area are similar to this, with an incised, active channel bordered by a shallow high-flow channel and floodplain. In these cases, there may be a sharp jump in the increased losses as flow spreads out onto the floodplain during high flows.

Ertec's estimate of recharge to the valley fill aquifer at a point approximately three miles north of Colstrip was made using a two-dimensional model of the system at steady state (Technical Support Document, Section B.1). Input considerations included rainfall, evapotranspiration, transmission losses, and tributary inflow. This analysis indicates that the amount of recharge to the valley fill aquifer is approximately 195 acre-feet per year.

g. Groundwater Discharge

Groundwater discharge to the East Fork Armells Creek drainage system (and specifically to its valley fill aquifer) takes the form of springs,

seeps, and upward leakage from the Rosebud aquifer. A value was estimated by Ertec using a two-dimensional steady state computer model of the valley fill system (Technical Support Document, Section B.1). This model indicates that the total amount of groundwater discharge to the system is approximately 130 acre-feet per year.

h. Hydrologic Budget Analysis

The hydrologic budget of the water transmitted in the valley fill aquifer of East Fork Armells Creek is based on Ertec's two-dimensional steady state computer model (Technical Support Document, Section B.1). The inflow to the system consists of discharge from the Rosebud aquifer, seepage from the Montana Power Company's surge pond, recharge and tributary inflow. Outflow from the system includes downward leakage, evapotranspiration losses, and the amount of underflow through the valley fill material out of the system.

Considering these parameters, the hydrologic budget for a location on East Fork Armells Creek approximately three miles north of the Colstrip townsite is as follows:

Inflow

Discharge from the Rosebud Aquifer:	130 acre-feet/year
Surge Pond Seepage:	175 acre-feet/year
Recharge and Tributary Inflow:	195 acre-feet/year
	500 acre feet/year

Outflow

Downward Leakage and Evapotranspiration:	375 acre-feet/year
East Fork Armells Creek Underflow:	125 acre-feet/year
	500 acre-feet/year

Total inflow = Total outflow

HYDROLOGY GLOSSARY

Aggradation: The building up of the grade or slope of a stream by the deposition of sediment.

Alluvium (alluvial): A general term for clay, silt, sand, gravel or similar unconsolidated material deposited during comparatively recent geologic time by a stream or other body of running water.

Aquifer: Stratum or zone that contains sufficient saturated permeable material to produce water to a well or spring.

Base flow: The sustained runoff of a stream system, primarily composed of effluent groundwater; the natural flow of a stream unaffected by peaks due to storms, snowmelt, or the works of man.

Base Level: The lowest level to which erosion of the earth's surface constantly progresses; the level below which a stream cannot erode its bed; the level at which stream equilibrium exists.

Boundary: (As it refers to hydrology) Indicates or fixes a limit of lower permeability that affects the hydraulic characteristics of a system, i.e., faults, springs, creeks.

Clinker (Porcelanite) - Fused shales and clay that occur as a result of burned coal seams.

Colluvium (colluvial): A general term applied to loose and incoherent deposits, usually at the foot of a slope or cliff and moved chiefly by the force of gravity.

Confined: Refers to a groundwater aquifer under sufficient hydrostatic pressure to rise above the surface of the aquifer when penetrated by a well and bounded by an impervious stratum directly above or below the zone bearing water.

Crop out: To appear exposed and visible at the surface of the earth.

Dip: The angle that a bedding plane makes with the horizontal.

Discharge area: An area in which subsurface water, including both groundwater and vadose* water is discharged to the land surface, to bodies of surface water, or to the atmosphere.

Dissolved Solids: The quantity of dissolved material in a sample of water; the residue on evaporation or the sum of determined constituents; results are usually reported in milligrams per liter.

Electrical conductivity: A measure of the ability of a solution to conduct an electrical current, measured in millimhos. It is used on soil extracts as a measure of the soluble salts in soils.

Energy grade line: A line joining the elevations of the energy heads of a stream when referred to the stream bed.

Ephemeral stream: A stream or portion of a stream that flows only in response to precipitation. Its channel is at all times above the water table.

Erosion rates: The amount of soil loss per unit land area for a given time frame.

Evapotranspiration: Loss of water from a land area through the transpiration of plants and evaporation from the soil.

Flexure: A fold; a monocline formed by warping or other gentle deformation rather than by compression.

Gaining stream: A stream or reach of a stream that receives water from a zone of saturation and provides base flow; its channel lies below the water table.

Hardness of water: A physical-chemical characteristic that is commonly recognized by the increased quantity of soap required to produce a lather. It is mainly attributable to the presence of calcium and magnesium and is expressed as equivalent calcium carbonate ($CaCO_3$) in milligrams per liter.

Hummocky: Abounding in rounded or conical knolls, mounds, hillocks generally of equidimensional shape and not ridge-like.

Hydraulic conductivity: The rate of flow of water through a one square foot cross section under a unit hydraulic gradient, measured in feet per day (ft/day).

Hydraulic gradient: In a aquifer, the rate of change of pressure head per unit distance of flow; in a stream, the slope of the "energy grade line.*"

Hydrogen-ion concentration (pH): Indicates the degree of acidity or alkalinity of water and is expressed in terms of pH units. The pH value of a solution is the negative logarithm of the concentration of hydrogen ions, in moles per liter.

Interburden: At the Rosebud and Big Sky Mines, Montana, the consolidated material that separates the Rosebud and McKay coal beds.

Intermittent stream: A stream that does not flow continuously. Flow occurs in response to precipitation, snowmelt, and groundwater inflow.

Knickpoint: Points of abrupt change in the longitudinal profile* of stream valleys.

Longitudinal profile: The surface of a valley bottom or stream, drawn along its length from the source to the mouth of the stream.

Losing Stream: A stream or reach of a stream that contributes water to the zone of saturation; its channel lies above the water table.

Milligrams per liter (mg/l): A unit expressing the concentration of chemical constituents in solution. Milligrams per liter represents the weight of solute per unit volume of water.

Normal fault: A fault in which the hanging wall (or overlying side) appears to have moved downward relative to the footwall (or underlying side).

Outcrop: The exposure of bedrock or strata at the surface of the earth.

Overburden: Consolidated or unconsolidated material that overlies a coal bed.

Permeability: The capacity of porous rock, sediment, or soil for transmitting a fluid.

pH: See hydrogen-ion concentration.

Porosity: The percentage of bulk volume of rock or soil occupied by pores.

Potentiometric: Refers to an imaginary surface representing the static head of groundwater, defined by the level to which water will rise in a well.

Recharge area: An area in which water is absorbed that eventually reaches the zone of saturation in one or more aquifers.

Reverse fault: A fault in which the hanging wall (or overlying side) appears to have moved upward relative to the footwall (or underlying side).

Salinity: Qualitative term expressing the soluble salt content of a solution or material.

Salinity hazard: The impact of salt content in irrigation waters on crop growth. It depends on the dissolved solids in the irrigation water, soil condition, drainage, and management practice.

Sediment yield: The actual amount of eroded material delivered by a stream system to a given point in a drainage basin or subbasin.

Semi-confined: Refers to a regional groundwater aquifer that exhibits both confined and unconfined characteristics.

Sinuosity: ratio of the length of the channel to the down-valley air distance; streams with sinuosities of greater than 1.5 are called "meandering."

Specific conductance: A measure of the ability of water to conduct an electrical current, expressed in micromhos per centimeter at 25°C. Because the specific conductance is related to the number and type of ions in solution, it can be used for approximating the dissolved solids content in the water.

Spoils: At the Rosebud and Big Sky Mines, Montana, the reworked Rosebud coal overburden material, which has been replaced where the Rosebud coal has been mined out.

Storage coefficient: The volume of water an aquifer releases from or takes into storage, per unit surface area of the aquifer per unit change in head.

Subcrop: A buried outcrop.

Subirrigation: Supplying water to plants from underneath or from a semi-saturated or saturated zone where water is available for use by vegetation.

Terrace: Horizontal or gently inclined, relatively flat surfaces which are bounded by a steeper ascending slope on one side and by a steeper descending slope on the opposite side.

Transmission loss: The loss of stream flow to the alluvium (Syn: losing stream)

Transmissivity: Measure of the ability of an aquifer to transmit water through a unit width under a unit hydraulic gradient measured in gallons per day per foot (gpd/ft).

Unconfined: Refers to a groundwater aquifer that has a free water table, i.e., water not confined under pressure beneath relatively impermeable rocks.

Vadose water: Water in the zone of aeration.

Valley fill material: The unconsolidated colluvium and alluvium deposited by any agent so as to fill or partly fill a valley.

C. CLIMATE

Southeastern Montana, including the Colstrip area, has a continental climate. The majority of large-scale weather systems move from west to east, and being on the lee side of the Rocky Mountains, the Colstrip area is influenced by descending air masses characterized by the dissolution of clouds, and thus, clear-sky conditions and temperature extremes. In winter, inversions predominate; in summer radiation increases atmospheric turbulence (USGS, No date).

1. Temperature

Summers are characterized by warm days, but most nights, even during midsummer, cool down to 60 degrees F or less, so oppressive hot spells are not very common. Temperatures of 90 degrees F or more occur about 40 days each year and can occur in any month from May through October. The average temperature during the warmest month at Colstrip (July) is 71.5 degrees F. During July the average maximum temperature is 89.2 degrees F and the average minimum is 53.8 degrees F.

During winter, nights generally cool to less than 15 degrees F at night, but warm to 30 degrees F or better during the day. An occasional cold spell will generate sub-zero temperatures, but these spells seldom last more than two or three days. The average temperature during the coldest month (January) is 21.0 degrees F. During January the average maximum temperature is 34.4 degrees F and the average minimum is 7.7 degrees F.

The annual average temperature at Colstrip for the period 1941 to 1970 was 45.9 degrees F.

2. Humidity

The annual average relative humidity for the townsite of Colstrip was 55 percent in 1976 and 68 percent in 1977. The relative humidity has a wide diurnal variation related to similar variation in air temperature and a relatively constant amount of ambient moisture.

3. Precipitation

The annual average precipitation at the Colstrip National Weather Service station is 15.8 inches. Three-fourths falls during the April through September growing season. Winter precipitation is generally light with just over half an inch a month during the period November through February. Most of the precipitation during this time is in the form of snow. The average snowfall at Colstrip is 34.6 inches.

4. Severe Weather

Hailstorms are typically the most common and damaging form of severe weather in Montana and occur mainly in July and August. Floods may occur in spring and early summer as a result of the melting snowpack, but are more likely due to locally heavy thundershowers in late spring and summer.

5. Evaporation

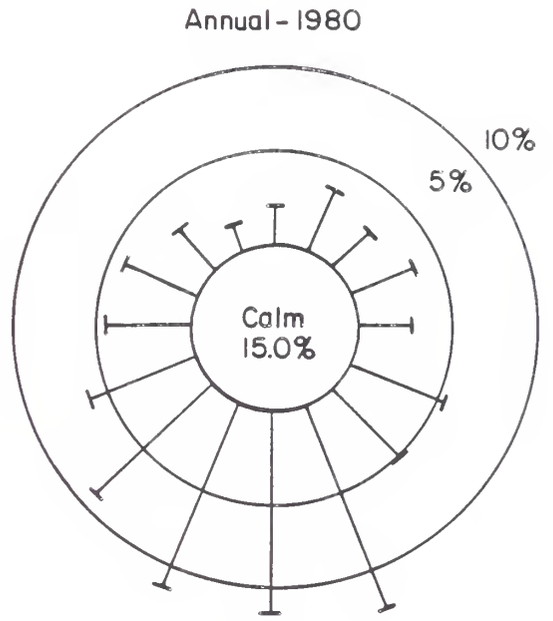
The nearest National Weather Service station measuring evaporation rate is at Terry, Montana, about 90 miles northeast of Colstrip. Over a five- to ten-year period, the average total evaporation for May through September was 40 inches. Evaporation data are not obtainable from October through April because periods of below freezing weather frequently occur.

Evaporation rate is also measured at the Absaloka Mine by Westmoreland Resources, about 25 miles west of Colstrip. During 1979 (May 7 through September 17), total evaporation measured was 35.7 inches, or about 0.42 inches per day.

6. Dispersion Meteorology

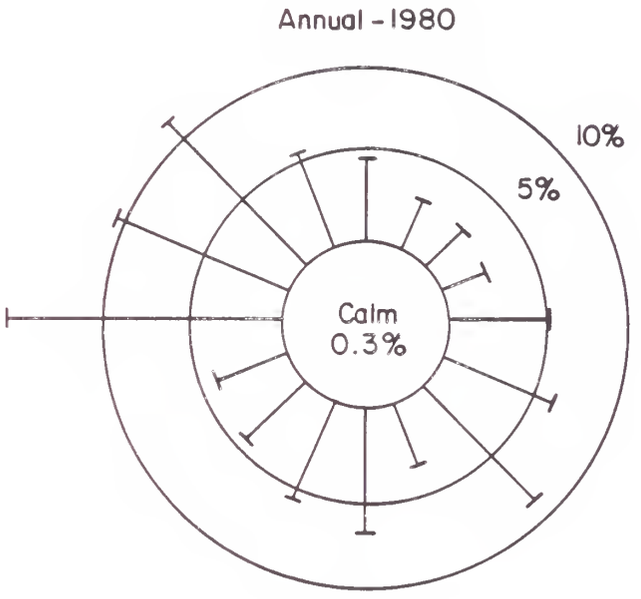
Since the primary air pollutant emissions related to the proposed mining operations at Area C, Block I are particulates released from ground level or near-ground level sources, the meteorological parameters that affect air pollution potential the most are precipitation and/or soil moisture content, surface wind, and mixing height. Surface wind speed determines how fast the air pollutants are removed from the area, and in the case of fugitive emissions, the amount of air pollutants that are entrained into the atmosphere. The wind direction simply dictates where the air pollutants are transported. Therefore, atmospheric stability is important to the air pollution potential because if repeated or extended stable conditions occur, air pollutants will tend to accumulate in an area. Finally, mixing height is the height above the ground to which the air pollutants are carried or mixed. If mixing heights are low, air pollutants are contained in smaller volumes and concentrations are greater.

Surface wind speed and direction are monitored by Western Energy at the meteorological station located on a ten-meter tower inside the train loop in Area A (see Figure I-2). Figure II-17 summarizes the surface winds for 1980. Because of the predominance of southerly wind directions during several of the seasons, the annual windrose also shows a predominance of southerly winds. Strongest wind speeds were from the west-southwest, while slowest wind speeds were from the east. Calm conditions occurred 15 percent of the hours. Wind speeds in excess of 13 miles per hour occurred about ten percent of the hours, but wind speeds in excess of 25 miles per hour occurred less than one percent of the hours.



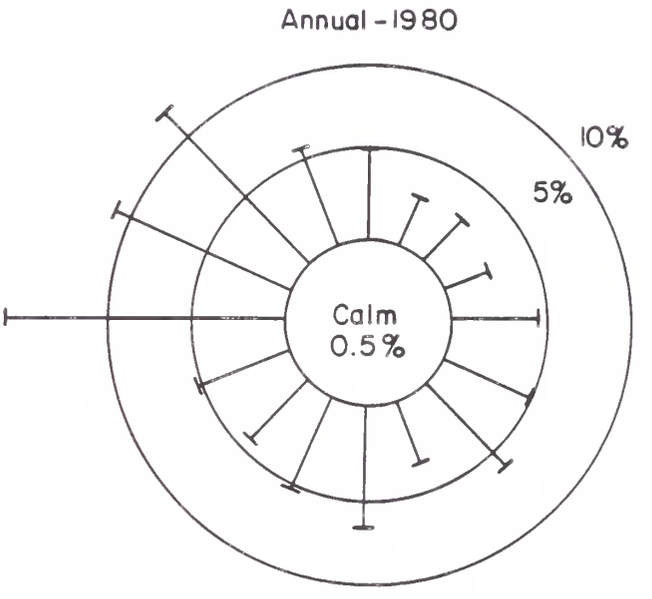
10 meters

(WESTERN ENERGY CO.)



31 meters

(MONTANA POWER CO.)



93 meters

(MONTANA POWER CO.)

FIGURE II-17 COLSTRIP AREA ANNUAL WIND FREQUENCY DISTRIBUTIONS

Although a wind direction shift to a more westerly direction with increased elevation is predictable, the shift of some 90 degrees from the Western Energy ten-meter site to the MPC 31-meter level is more than expected. The MPC tower is located on top of a 30-meter hill, which can account for some difference. However, it appears likely that either local terrain influences or instrument problems account for the wind direction changes.

Mixing heights (or vertical temperature above 100 meters) have not been routinely measured in the Colstrip area. Montana State University (MSU) measured vertical temperature using aircraft in the Colstrip area during 1971-1972 (MSU, 1973). Results from the MSU measurements indicated Glasgow mixing heights were quite similar to Colstrip heights except during spring. Annually Colstrip and Glasgow mixing heights were very similar. Holzworth (1972) reported Glasgow mixing heights as shown below.

GLASGOW, MONTANA MIXING HEIGHTS*
(Values in meters)

	Annual	Winter	Spring	Summer	Autumn
Morning	310	283	391	304	262
Afternoon	1564	524	1971	2454	1307

* Holzworth (1972)

D. AIR QUALITY

The following discussion is limited to particulate matter since the source of concern is a surface coal mine. Other, gaseous pollutants have been monitored in connection with MPC's generating Units 1 through 4, but the discussion only addresses those issues that are associated with the proposed mine operation.

1. Ambient Air Quality Standards

Air quality standards applicable to pollutant sources in the Colstrip area are those resulting from the Federal Clean Air Act and the Montana Clean Air Act. The Montana Ambient Air Quality Standards (MAAQS) and the National Ambient Air Quality Standards (NAAQS) are outlined in Table II-9. The NAAQS are expressed as both primary and secondary standards. Primary standards are those required, with an adequate margin of safety, to protect public health. Secondary standards are those necessary to protect the public welfare from any known or anticipated adverse effects associated with air pollutants.

Because of the high particulate matter levels, an area of 120 square miles centered on Colstrip has been designated as a non-attainment area for TSP. Part of the Area C, Block I mining operation is within this designation.

2. Total Suspended Particulates

Western Energy presently monitors TSP at ten sites around Colstrip; additionally, MPC monitors TSP at four locations. The location of these monitors is shown in Figure II-18.

Examination of the data from the existing Western Energy mining areas (Western Energy 3, 4, 6) reveals that current levels exceed both the NAAQS and the MAAQS. Short-term concentrations as high at 6,585 ug/m^3 have been recorded. The three samplers near or in Colstrip (Western Energy 1 just southwest of Colstrip, Western Energy 2 south of Colstrip; MPC 3 in the center of town) generally are near or exceed the 24-hour standards. The Montana annual arithmetic standard of 75 ug/m^3 has been exceeded at all three sites, although only MPC 3 exceeds the federal primary annual geometric standards of 75 ug/m^3. Western Energy has recently moved its monitoring station 2 to a new location where lower concentrations are being observed. According to a letter to the Montana Air Quality Bureau (MAQB) from Western Energy (August, 1980), Western Energy Company #2 was moved due to realignment of the county road. The sampler was moved to Area B (from Area A) in anticipation of monitoring emissions from Area B moving toward Colstrip. The relocation was approved by the MAQB.

The samplers located further from Colstrip and not in the mining areas generally reveal particulate concentrations below the NAAQS and MAAQS. Only the MPC samplers have measured short-term particulate concentrations near or above the standards. Annual particulate concentrations at these more distant sites are well below the ambient standards. It should be noted that NAAQS and MAAQS are considered to be violated if

TABLE II-9

MONTANA AND NATIONAL AIR QUALITY STANDARDS

POLLUTANT	MONTANA STANDARD	FEDERAL PRIMARY STANDARD	FEDERAL SECONDARY STANDARD
Total Suspended Particulates	75 ug/m^3 annual arithmetic average 200 ug/m^3 24-hr average*	75 ug/m^3 annual geometric mean 260 ug/m^3 24-hr average*	60 ug/m^3 annual geometric mean 150 ug/m^3 24-hr average*
Sulfur Dioxide	0.02 ppm annual average 0.10 ppm 24-hr average* 0.50 ppm 1-hr average**	0.03 ppm annual average 0.14 ppm 24-hr average*	0.5 ppm 3-hr average*
Carbon Monoxide	9 ppm 8-hr average* 23 ppm hourly average*	9 ppm 8-hr average* 35 ppm 1-hr average*	9 ppm 8-hr average*
Nitrogen Dioxide	0.05 ppm annual average 0.30 ppm 1-hr average	0.05 ppm annual average	0.05 ppm annual average
Photochemical Oxidants (ozone)	0.10 hourly average*	0.12 ppm 1-hr average*	0.12 ppm 1-hr average*
Lead	1.5 ug/m^3 90-day average	1.5 ug/m^3 calendar quarter average	None
Foliar Fluoride	35 ug/g grazing season 50 ug/g monthly average	None None	None None
Hydrogen Sulfide	0.05 ppm hourly average*	None	None
Settled Particulate (Dustfall)	10 gm/m^2 30-day average	None	None
Visibility	Particle scattering coefficient of 3×10^{-5} per meter annual average***	None	None

* Not to be exceeded more than once per year
ug/m^3 micrograms pollutant per cubic meter of sampled air
ppm parts pollutant per million parts of sampled air

** Not to be exceeded more than 18 times per year

*** Applies to PSD Class I areas

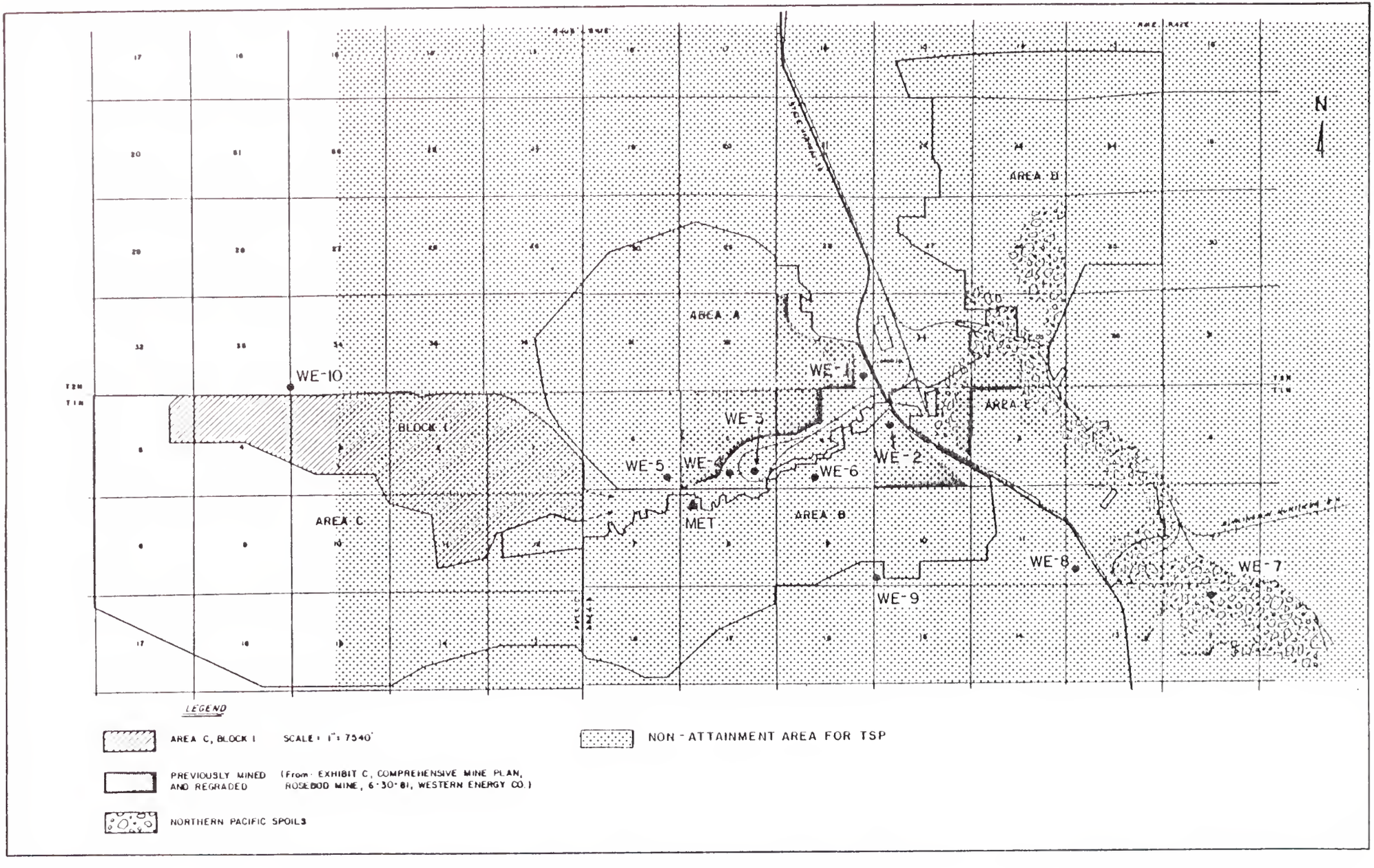


FIGURE II-18 HIGH VOL. & MET. STATIONS

values are obtained from samplers located in areas where the public would have access. Values greater than the standards at monitors located on company property are not considered violations of the standards.

Because of the high particulate matter levels, an area of 120 square miles centered on Colstrip has been designated as a non-attainment area for TSP. The U.S. Environmental Protection Agency (EPA) designated the attainment status of this area and various other areas in Montana on March 3, 1978 (43 FR 9009-9010). The state of Montana submitted a revision to the State Implementation Plan (SIP) on April 23, 1979 in which the state committed to bring the Colstrip area into compliance with both the annual and 24-hour NAAQS TSP standards by December 31, 1982. The Montana Department of Health and Environmental Sciences (MDHES) proposes to attain these standards through the enforcement of a revised airborne particulate rule by requiring existing mining operations to meet conditions of required operating permits. In the meantime, for any mine to expand in the non-attainment area, the mining company must demonstrate that it is decreasing nonfugitive particulate emissions in the area to a degree greater than will be generated by its proposed expansion. This is known as "offset" under the state and federal air regulations. The requirements hold true for any other major plant that might be sited in the non-attainment area.

The particulate situation in the Colstrip area is characteristic of fugitive dust impacts. Because the emission sources causing the problem (e.g., mining dust, construction dust, vehicular travel on paved and unpaved surfaces, and the coal handling around the power plant) produce particulates of a relatively large size (PEDCO, 1981; TRC, 1981), the dust settles out quickly and the impacts are very localized. Areas not close to any significant source generally experience low concentrations. Area C, Block I currently experiences very low particulate concentrations on the order of 25 ug/m^3 annual arithmetic mean based on Western Energy monitor numbers 10 and 11.

Fugitive dust problems of this type are relatively difficult to solve. Western Energy has in recent years undertaken a number of new dust control measures at their existing operations. A detailed discussion of these actions is provided in the EIS prepared for Area B (Montana DSL, 1980). The results have not significantly reduced TSP concentrations in Colstrip, partly because local sources in town, including construction sites, the coal handling facilities for Units 1 and 2, and unpaved roadways may be responsible for a sizable percentage of the impact, and because the amount of emissions reduction was small when compared to total emissions.

3. Settled Particulates

Settled particulate samplers or dustfall buckets are presently located at five of the Western Energy TSP sites. No federal ambient standard addresses dustfall. The Montana 30-day average standard of ten grams per square meter has been exceeded at Western Energy 3, 4, and 6, all in the train loop area. At Western Energy 7 (located in reclaimed portions of Area E) and 11 (located in Area C) dustfall amounts exceeded

the Montana standard during 1981. Dustfall levels exceeded the Montana standard in the past; however, sampling at Western Energy 5 (about one-quarter mile southwest of Area A) and 8 (two and one-half miles southeast of Colstrip) was discontinued in 1980. The settled particulate values follow the pattern of fugitive dust areas. The large-sized particles produced by fugitive dust sources settle readily and generally occur in large quantities.

4. Visibility

Ambient visibility has not been measured in the immediate Area C, Block 1 vicinity. However, an estimate of visual range (a measure of visibility) can be made using TSP measurements. In this way a value of 35 miles is derived for the existing visual range in the area. The Technical Support Document provides the details of this computation.

E. NOISE

Existing sound levels have not been measured in Area C, Block 1, but are believed to be very low. Summer sound levels are generally slightly higher than winter due to bird and insect noise. Noise related to man's activities is presently limited to occasional blasting from other nearby mining operations.

The 1979 Colstrip Project EIS (U.S.D.I, 1979) reported measurements taken some distance from the town. It was found that the tone radiating from the generating plant stack was distinctly audible, with a sound level of 37 dBA at a distance of 2.6 miles from the plant. At 3.8 miles from the plant, the tone was marginally audible at 32 dBA. It was assumed from these measurements that the background ambient sound level in the Colstrip area would be approximately 29 dBA if no noise source existed in the area. Thus the ambient sound levels in Area C, Block I are probably about 29 dBA.

Sound levels in the townsite of Colstrip have been documented more thoroughly. The 1979 Colstrip Project EIS discussed measurements at a variety of locations in and around the townsite. Due to the presence of generating Units 1 and 2, the sound levels observed (53 to 68 dBA) were more typical of an urban area than a small town. The measurements reported in the Colstrip EIS indicate that the L_{eq} (24) at two community locations was less than the 70 dBA level that might cause hearing loss, but greater than the 55 dBA that causes interference with outdoor speech and activities.

Neither Montana nor the townsite of Colstrip has specific ambient noise regulations. The Environmental Protection Agency, however, has published noise level guidelines in "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety" (EPA, 1974). Since the identified sound levels consider neither cost nor technical feasibility, EPA states that its guidelines are not to be interpreted as federal ambient noise standards, but rather as information for state and local government use in establishing their regulations. These levels are summarized in Table II-10.

TABLE II-10

SUMMARY OF NOISE LEVELS IDENTIFIED
AS REQUISITE TO PROTECT PUBLIC HEALTH
AND WELFARE WITH AN ADEQUATE MARGIN OF SAFETY

Effect	Level	Area
Hearing loss	$L_{eq} \leq 70$ dBA	All areas.
Outdoor activity	$L_{dn} \leq 55$ dBA	Outdoors in residential areas, farms, and other areas where people spend widely varying amounts of time and other places in which quiet is a basis for use.
	$L_{eq} \leq 55$ dBA	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor activity intereference and annoyance	$L_{dn} \leq 45$ dBA	Indoor residential areas.
	$L_{eq} \leq 45$ dBA	Other indoor areas with human activities, such as schools, etc.

* In this table, L_{eq} refers to a 24-hour equivalent sound level; this is the constant sound level that has the same sound energy as a time-varying sound would over a 24-hour period. L_{dn} is a 24-hour equivalent sound level in which the nighttime (10:00 p.m. to 7:00 a.m.) sound levels are increased by 10 decibels to account for the added annoyance due to sleep interference.

F. SOILS

The soils of the Area C, Block I permit area are predominantly light-colored soils with weakly developed subsoils and thin, dark-colored surface layers (Aridisols). Other, less common soils in the area include poorly developed soils (Entisols) in which very little alteration from the underlying material has occurred (Soil Survey Staff, 1975).

Eighteen soil series have been recognized within the permit area in detailed mapping and sampling (Western Energy Permit Application, Area C, Block I). These can be grouped into four major soil types by similarities in parent material, texture, and landscape position. The four soil groups include:

- Sandy Residual Soils
- Alluvial Loamy and Clayey Soils
- Clinker Soils
- Unbaked Shale and Siltstone Soils

Each group represents several soil mapping units recognized in detailed soil mapping as occupying similar landscape positions and having similar physical characteristics. Table II-11 shows the characteristics of these groups, and detailed supporting summaries are included in Appendix F. Figure II-19 shows the general distribution of these soil types within Block I. Detailed large-scale maps of the Block I permit area and descriptions of each soil series and mapping unit can be found in the Area C, Block I permit application prepared by Western Energy.

The proposed disturbed area includes the crusher facility, the mine shops, the haul roads, clinker (locally known as scoria) pits, topsoil stockpile, and highwall and boxcut reduction zones, in addition to the mine pit itself. These disturbances are anticipated to total 1,627 acres of the 2,693-acre permit area.

1. Sandy Residual Soils

These soils are formed in material weathered from sandstones of the Tongue River member of the Fort Union Formation, which are weakly consolidated calcareous sandstones capping many of the many rolling hills in the Colstrip area. This group represents 44 percent of the 1,627-acre disturbed area. The Busby, Reidel, Yetull, and some areas of the Cooers soil series are included in this group (refer to Table 1, Appendix F).

Two landforms and vegetation types can be recognized within this group. Hilltops and ridges containing small knobs and weathering outcrops of sandstone commonly have sandstone within 40 inches of the surface. Scattered ponderosa pine (Pinus ponderosa) and skunkbush sumac (Rhus trilobata) occur in these areas, with an understory of tall and midgrasses.

In the gently rolling portions of this unit, sandy material commonly extends to a depth of more than 40 inches before sandstone is encountered.

TABLE II-11

CHARACTERISTICS OF GENERAL SOIL GROUPS
AREA C, BLOCK I

Soil Group	Acreage	Percent of Disturbed Area	Limitations	Proposed Salvage Depth Topsoil (feet)	Proposed Salvage Depth Subsoil (feet)	Approximate Reclaimed Area Reclaimed Acreage*	Approximate Reclaimed Area Percent
Alluvial Loamy and Clayey Soils	710	44%	High salts in subsoil, occasional high clay	1.0	0.5-3.5	947	58%
Sandy Residual Soils	710	44%	Excess sand, depth to rock	0.5	1.0-2.5	580	36%
Clinker Soils	138	8%	Depth to fractured rock, slope	0.5	1.0-1.5	80	5%
Unbaked Shale and Siltstone Soils	69	4%	High salts, depth to rock, high clay	0.5	0-2.5	20	1%

* Assumes an average replaced topsoil thickness of 8" and replaced subsoil thicknesses ranging from 26-28".

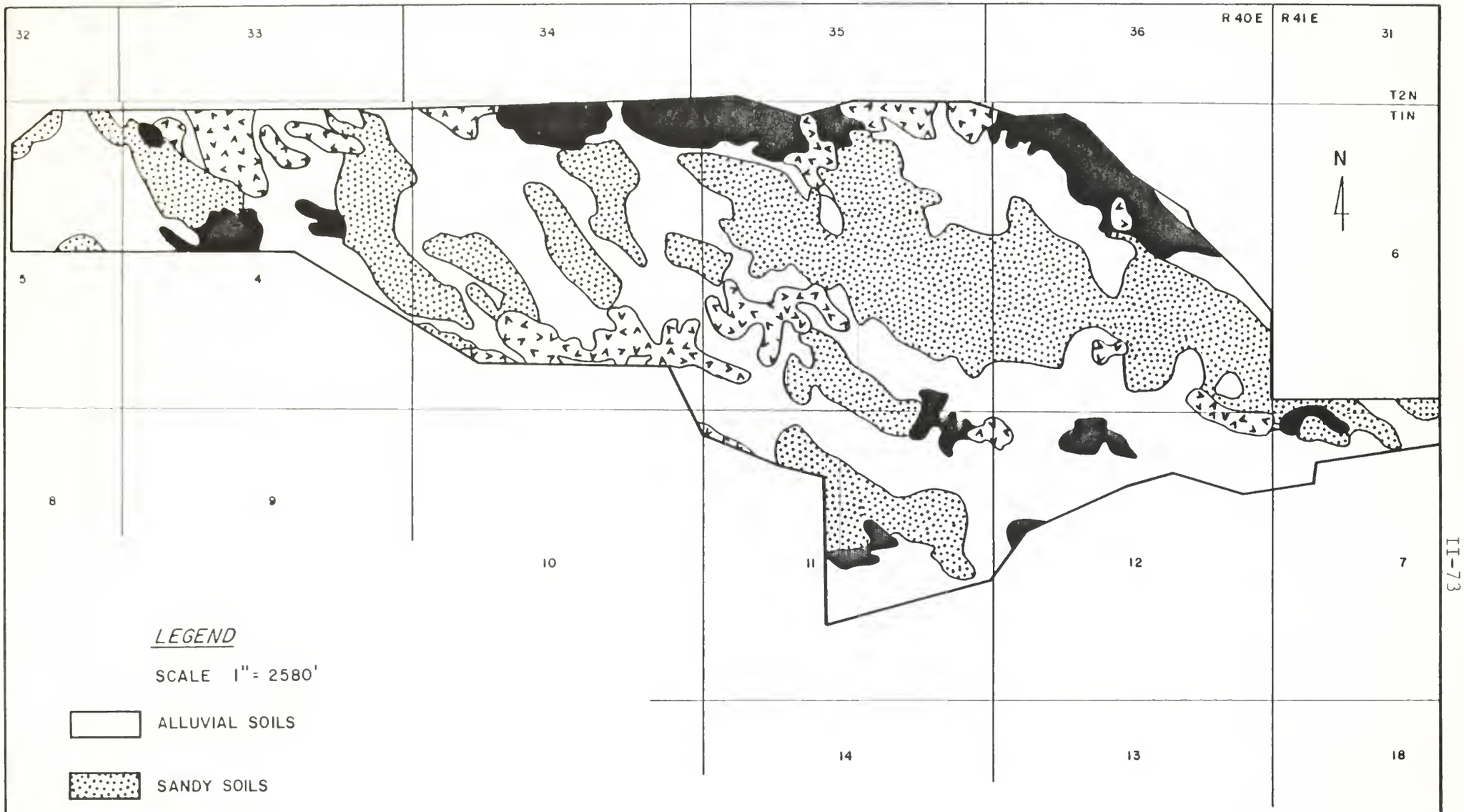


FIGURE II-19 GENERAL SOIL GROUPS, AREA C, BLOCK I

Ponderosa pine and skunkbush sumac stands are rare in these rolling areas; instead, cool-season grasses dominate the vegetation. The adapted climax community for this soil type includes a large component of productive deep rooted warm-season grasses (USDA-SCS, 1981).

Sandy residual soils are best suited to grazing use. Crop production is limited by low available water in the surface soil layers where most annual crops have their roots. This results in low crop yields and increased wind and water erosion, especially during drought years. Of the few areas where cropping has been attempted in Area C, Block I, most have been replanted to grass for grazing.

The soils of this group are limited for topsoil use by excess sand content. DSL guidelines suggest that soils containing an excess of 70 percent sand are a poor source of topsoil or subsoil. All of the soils in this group occasionally exceed the recommended limits of sand (see Technical Support Document).

2. Alluvial Loamy and Clayey Soils

Deposition of mixed loamy and clayey material has occurred at the bases of hills and on benches and terraces along the drainages of Area C, Block I. The soils occurring at these locations represent 44 percent of the soils to be disturbed in Block I, and include the Yamac, Kremlin, Lonna, Vanstel, Kobar, and Havre soil series and the undifferentiated unit referred to as Ustic Torriorthents. The major limitations for salvaging these soils include moderate to high electrical conductivities in some of the subsoil layers and occasionally excess clay.

The soils in this group commonly extend to 60 inches or more before bedrock is encountered, and have moderate water availability in the surface soil layers, which is critical to the successful establishment of crops. A majority of the land presently under cultivation in Block I occurs in the gently sloping portions of this soil group. This indicates that the soils of this group are well-suited to small grain production, limited only by regional characteristics of low rainfall and the short growing season. In soil areas containing natural vegetation, shallow-rooted cool-season midgrasses dominate the existing plant communities in association with big sagebrush (Artemisia tridentata) and silver sagebrush (Artemisia cana). The adapted climax plant community for this site is also made up of shallow-rooted, cool-season midgrasses, in association with a smaller component of shrubs.

Excess clay content may be encountered in the Kobar and Vanstel soils, and all of the soils of this group may contain layers with high salts (Technical Support Document). Generally, these soils are good sources of topsoil and subsoil.

3. Clinker Soils

On scattered hilltops within the Block I area, reddish- or purplish-colored baked sandstones and shales occur, known as clinker or locally

as scoria. This material commonly occurs along ridge tops and on the crests of hills. Much of the clinker that occurs within the Area C, Block I permit area will be mined as a source of road base construction material, or disturbed by placement of the boxcut spoils. This soil group represents eight percent of the total 1,627 acres to be disturbed. It includes shallow rocky soils formed directly in the clinker (Birney and Kirby series), and soils formed in close association with the clinker hills, including portions of the Cabbart and Cooers series.

Clinker soils consistently support stands of ponderosa pine and Rocky Mountain juniper (Juniperus scopulorum), and of all the soils found in the vicinity of the Rosebud Mine, clinker soils support the most vigorous stands of these vegetation types (Richardson, 1981). This is apparently due to the competitive advantage to trees due to the apparent availability of free water at depth where bedrock is encountered (McQueen, 1982; Stark, 1980). Grass and shrub understories are also well established on these soils, although they are less dense than in other communities because of shading by trees and the mulching effect of the surficial rock fragments (Richardson, 1981).

4. Unbaked Shale and Siltstone Soils

This soil group includes residual soils forming in material weathered from shales and siltstones. They are often found in association with the clinker soils, except that the bedrock has not been baked by burning coal. The soils are widely variant, and occur in complex terrain (i.e., with steeply rolling hills and ridges and limited small swales or valleys between the hills).

This group includes the Cabbart, Delpoint, Yawdim, and Rentsac soils and occupies four percent of the proposed disturbance area. A majority of these soils are Entisols, weakly developed soils that vary only slightly from the bedrock from which they were derived. Most of the soils have bedrock at depths between 15 and 30 inches and scattered rock fragments on the surface. The primary limiting factors of the soils in this group are depth to rock, high clay content, and high salt content. These soils support a sparse cover of shrubs and scattered junipers.

5. Soil/Plant Relationships

From the above descriptions, it is apparent that a wide range of vegetative types occur in Area C. For some, especially the warm-season grasses characteristic of the tall grass prairie and ponderosa pine, the Colstrip area is near the edge of their extent (Howard, 1982). Compared to other plant communities in the area, the ponderosa pines and skunkbush sumac probably occur in microsites with lower moisture stress conditions (F.A. Branson, unpublished data, see Technical Support Document), indicating that one of the major reasons for their presence in portions of the Colstrip area may be the availability of additional soil moisture.

Work by the Water Resources Division of the U.S. Geological Survey in the Hanging Woman Creek area not far from Colstrip (USGS, 1981) has shown that a wide variability of soil moisture availability and plant stress can occur in a small area, due primarily to the physical characteristics of the soil.

In general, crops and shallow-rooted, cool-season grasses such as the wheat grasses are most competitive in soils such as the alluvial soils in Area C in which infiltration is relatively moderate or slow, allowing the near-surface root system to use much of the precipitation received in these areas. Where infiltration is relatively rapid and precipitation results in deeper soil wetting, such as in the deep sandy residual soils, deep-rooted grasses and shrubs have the competitive edge. If, in addition, a bedrock layer allows water accumulation at deeper layers, trees can take advantage of this more readily available water. Trees and shrubs are also found where readily available deep soil water occurs along drainages.

In steep areas, rapid infiltration rates (such as in the clinker soils) will prevent excess runoff, whereas moderate or slow infiltration rates will result in increased runoff such as on the unburned shale and siltstone soils. Increased runoff effectively reduces the amount of moisture available to plants. The "gumbo knob" vegetation type (Appendix G) occurs on the unbaked shale and siltstone soils, and reflects the low productivity and dominance of drought-resistant shrubs and grasses common to such a situation. Table II-12 illustrates the general characteristics of moisture availability to which the present or potential vegetative communities would be responding.

There are many other variables that complicate the simplification presented in Table II-12, including seasonal fluctuations, annual variability resulting from low or high precipitation periods, the introduction of other stresses on vegetation such as insect infestations, grazing, or rodent activity.

TABLE II-12

GENERALIZED SOIL/PLANT WATER RELATIONS

Soil Group	Runoff	Infiltration	Generalized Water Availability* Near Surface	At Depth	Adapted Vegetation*
Alluvial Soils					
Uplands	moderate	moderate/slow	moderate	moderate	Shallow-rooted grasses, big sagebrush
Drainage ways	low	moderate	moderate	high	Silver sagebrush, chokecherries
Sandy Residual Soils					
Deep sands (rolling uplands)	low	rapid	low	moderate	Deep-rooted grasses
Sands over bedrock (hills and ridges)	low	rapid	low	high	Ponderosa pines, skunkbush
Clinker Soils	low	rapid	low	high	Ponderosa pines, skunkbush sumac
Unburned Shale and Siltstone	high	slow/moderate	low	moderate	Rabbitbrush sumac

* Highly competitive increaser species such as needle-and-thread grass and prairie junegrass are found in a majority of the area.

G. VEGETATION

The vegetation of the proposed permit area consists of a variety of grasses, forbs, shrubs, and trees. Cool-season perennial grasses are the dominant plants in terms of canopy cover and vegetative production. Several different native plant communities occupy various sites within the area. Ponderosa pine (Pinus ponderosa) is a highly visible species found growing in colonies on ridges and adjacent upper slopes. The native vegetation sites are used primarily for livestock grazing under present management systems. Existing vegetation also supplies important wildlife habitat and watershed protection.

Several sites within the permit area support introduced forage plants that are used for hay or pasture. A considerable acreage is presently cultivated for production of small grains, primarily winter wheat. Roads, ranch facilities, and localized mining of clinker (locally known as scoria) has resulted in the removal of vegetation from a small portion of the area. For the small areas involved, clinker mining has had only a minor impact or vegetation, the most obvious being the removal of ponderosa pine and the creation of small depressions in these areas. Coal mining on adjacent areas at the Rosebud Mine has not had a noticeable effect on the vegetation in Area C.

Of the total 2,693 acres within Area C, Block I, 71 percent (1,904 acres) is rangeland and ponderosa pine stands; 13 percent (334 acres) is hayland and pasture; 16 percent (436 acres) is cultivated for wheat; and one percent (19 acres) is disturbed land generally devoid of vegetation. No rare or endangered plant species have been identified in the area. The vegetative cover on the soils in these land use categories is further described in the following paragraphs.

1. Rangeland Vegetation

Western Energy has identified six rangeland plant communities in the proposed permit area. They have been identified and named according to the two or three plant species dominating the different sites at the time of examination. This approach identifies only the vegetation dominant when examined, a highly variable characteristic evidenced by the fact that the dominant and co-dominant plant species have changed for some communities even since measurements were begun in 1978. Therefore, in order to provide more basic ecological data for reclamation and management, the existing plant communities are compared with the potential communities of equivalent range sites, as described by the Soil Conservation Service in the Montana Technical Guide, Section II-8 (USDA-SCS, 1981). The key element of a range site is its ability to produce a characteristic plant community (USDA-SCS, 1976). A map designating range sites in Area C, Block I is provided in the Technical Support Document. This map correlates closely with Figure II-19.

Three basic vegetative types can be delineated from the six rangeland plant communities identified for detailed investigation. These are differentiated by major growth form and landscape position, and include: grassland, shrub-grassland, and conifer-shrubland as shown in Figure II-20.

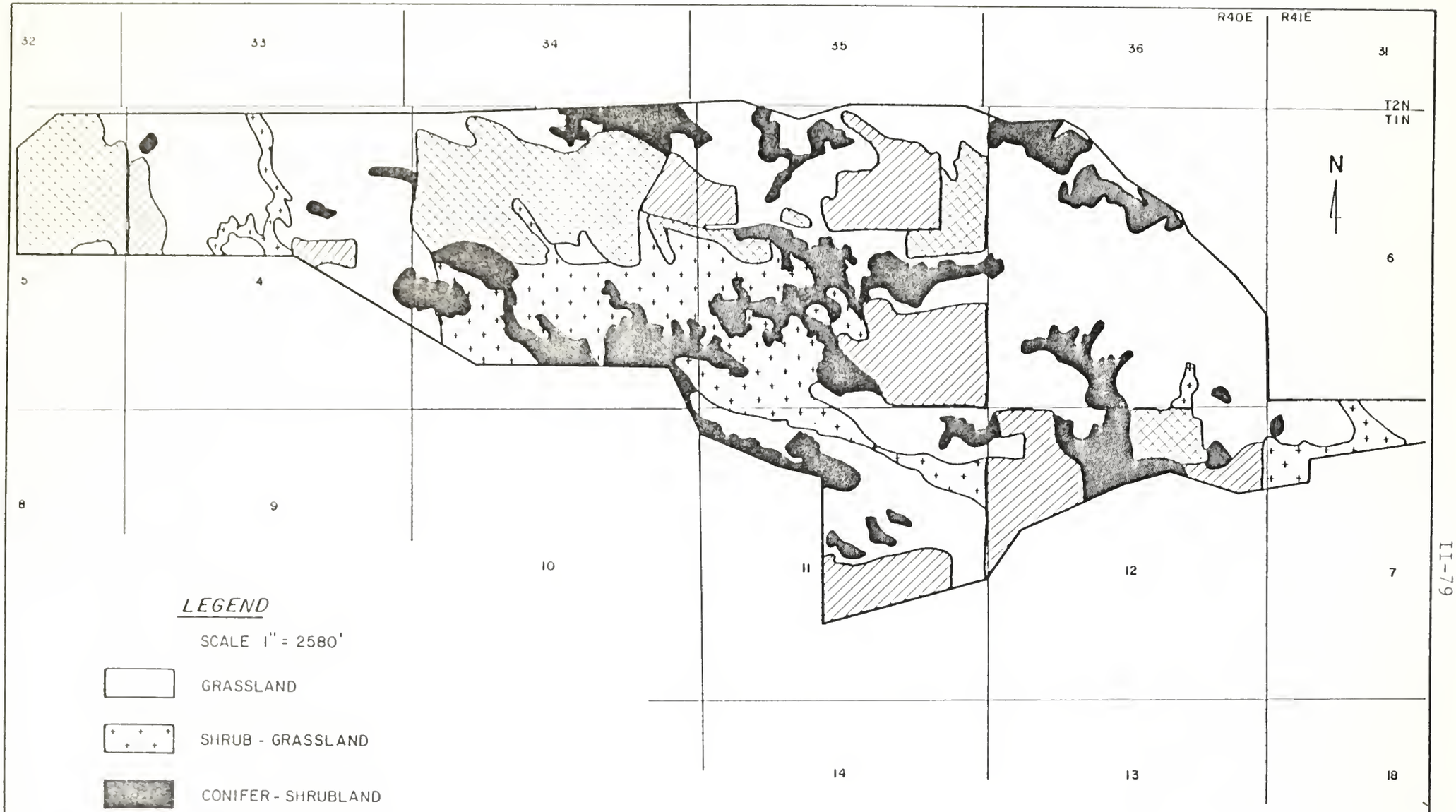


FIGURE II-20 GENERAL VEGETATION TYPES, AREA C, BLOCK I

- Grassland. This is the largest plant community in Area C, Block I. It comprises 60 percent (1,147 acres) of the rangeland in the proposed permit area. At present, needle-and-thread (Stipa comata), western wheatgrass (Agropyron smithii), and prairie junegrass (Koeleria cristata) dominate the community. The grassland community occupies two range sites, silty and sandy, as described by SCS. The climax dominants on the silty site are western and thickspike wheat grasses (Agropyron smithii and A. dasystachyum), bluebunch wheatgrass (Agropyron spicatum), and needle-and-thread, all cool-season grasses. The climax dominants on the sandy site are prairie sandreed (Calamovilfa rongifolia) and little bluestem (Schizachyrium scoparium), two warm-season grasses. Needle-and-thread, thickspike wheatgrass, and big bluestem (Andropogon gerardii) are of secondary importance on the sandy site. Apparently past grazing patterns have favored the cool-season grasses at the expense of the warm-season grasses.

  Forbs and shrubs are relatively minor components of both the existing and potential vegetative communities.

- Shrub-Grassland. This vegetative type occurs primarily on deep loamy to silty soils. It includes three communities dominated by three different shrubs: big sagebrush (Artemisia tridentata), silver sagebrush (Artemisia cana), and rubber rabbitbrush (Chrysothamnus nauseosus). The shrub-grassland vegetative type occupies about 23 percent (435 acres) of the rangeland in the proposed permit area. Big sagebrush (Artemisia tridentata) is the dominant species in upland positions. Bluebunch wheatgrass (Agropyron spicatum), green needlegrass, and other native cool-season grasses occur in association with the big sagebrush and make up nearly 30 percent of the vegetative production. Forb coverage is high.

  In swale and bench positions, silver sagebrush (Artemisia cana) is the dominant shrub, with skunkbush sumac (Rhus trilobata), western snowberry (Symphoricarpos occidentalis), and big sagebrush also occurring in association with the silver sage. Numerous forb species are present. Western wheatgrass (Agropyron smithii) and Kentucky bluegrass (Poa pratensis) are abundant. Cool season grasses account for nearly two-thirds of the vegetative canopy. Minor areas dominated by rubber rabbitbrush (Chrysothamnus nauseosus) occupy steeper portions of this general vegetation type.

  The two sagebrush communities correlate with the silty range site. The principal difference between the present and climax plant communities is the dominance of shrubs in the existing communities. In the climax community shrubs account for less than ten percent of the annual vegetative production.

  The rubber rabbitbrush community occupies a shallow clay range site. The existing community is similar in species composition to the climax.

- Conifer-Shrubland. Ponderosa pine in scattered to moderately dense stands with adjacent areas of skunkbush sumac are characteristic of this site. Stand density ranges from 32 to 360 trees per acre (Western Energy Company, 1980). Rocky Mountain juniper (Juniperus scopulorum) is a minor component of the community. This community occupies 17 percent (330 acres) of the rangeland in Area C, Block I.

  The stands of pine have an average age of 50 years and an average height of 28 feet. The predicted height at 100 years of age is 48.7 feet. This community is generally found on the rocky, shallow, and moderately deep soils often associated with weakly consolidated sandstone or clinker outcrops. The presence of pine appears to be favored by soils having rapid infiltration and percolation rates, which cause precipitation to become readily available to tree roots. At the same time, a less favorable moisture regime is created for competing herbaceous plants, primarily grasses.

  Canopy cover of the understory and open areas consists of grasses, forbs, and shrubs, including silver sagebrush, prairie rose (Rosa arkansana), yucca (Yucca glauca), and shrubby evening primrose (Oenothera serrulata). Dominant grasses and grasslike plants include needle-and-thread, threadleaf sedge (Carex filifolia), and prairie sandreed.

  Because of the slow growth rate of ponderosa pine in the area, the stands have low potential for timber production. The site is considered to be rangeland rather than woodland. Its present value and function are primarily for wildlife habitat, aesthetics, grazing, and watershed protection. Range sites are usually thin sandy where this community occurs.

2. Range Condition and Production

Range condition is the present state of vegetation of a range site in relation to the climax (natural potential) for that site, and may be expressed as excellent, good, fair, or poor depending upon the degree that the present plant community reflects that of the climax. Forage production is usually related directly to range condition. Rangeland in fair condition can be expected to produce less than 50 percent of the site potential, while rangeland in good condition should produce 50 to 75 percent of the site potential. It should be noted that sites in lower range condition classes may produce greater total biomass than the preceding statement would indicate. This could occur when invader or secondary climax species dominate a site and growing conditions are favorable for their vegetative expression.

Overall range condition in Area C, Block I is fair. The suggested initial stocking rate is about five acres per animal unit month. At this stocking rate, the 1,904 acres of range will carry 63 cow-calf units for a six-month grazing period. Information on range condition and

production of the vegetative communities in Area C, Block I is summarized in Table 1 in Appendix G.

3. Cropland

The 436 acres of cropland in Area C, Block I are used primarily for production of winter wheat in a wheat-fallow cropping system. Average yields are reported to range from 20 to 30 bushels per acre (Hydrometrics, 1981). A majority of these areas occur in loamy and clayey soils. Vegetative cover is provided by the growing wheat crop, the standing stubble after harvest, and crop residues remaining after summer-fallow tillage. Aside from the grain produced, vegetative production on an air-dry basis ranges between 2000 and 3000 pounds per acre (Greb, 1977).

4. Pasture and Hayland

Vegetation on haylands and pasture consists primarily of introduced cool-season grasses and legumes. Various fields support a stand of either crested wheatgrass (Agropyron cristatum), alfalfa (Medicago sativa), or a mixture of the two species. Forage yields for hay are reported to range from one-half to two tons per acre annually, with the average yield being 1.2 tons per acre (see Land Use, Section J). These areas are not irrigated on a regular basis.

H. WILDLIFE

An extensive wildlife data base exists relevant to the Rosebud Mine. Western Energy has sponsored wildlife investigation programs that have been under way since before 1973. Under this program data has been collected on big game, upland game birds, raptorial birds, songbirds, waterfowl, mammalian predators, small mammals, and reptiles and amphibians. No specific studies were conducted on reptiles, amphibians, and fish. The study area is shown in Figure 1, Appendix H.

Although surface mining of coal in the Colstrip area has been active for many years, no mining has occurred in Area C. Mining in Colstrip areas prior to 1973 was not subject to reclamation requirements, consequently, most of the reclamation activity there has been recent. Areas A, B, and E have active reclamation plans designed to rehabilitate disturbed lands to productive condition. It is unknown what effect, if any, past and ongoing mining activities outside of Area C may have had on the wildlife populations of the area. The destruction of habitat by mining and related surface developments may have decreased the maximum potential wildlife carrying capacity of the area and increased exposure of wildlife to human activities may have adversely affected survivorship and production of wildlife, but the actual impact of such changes is unknown.

1. Big Game

Most big game data is from aerial surveys conducted throughout the year. Although aerial surveys can yield indications of abundance and distribution of big game and herd composition by sex and age class, absolute quantification of these parameters is seldom feasible. There are several potential sources of bias in this methodology, including:

- Flight speed, altitude, and spacing - flying faster, higher or more widely spaced transects reduces total data capture (observation or sampling efficiency).
- Topography and vegetation - topographic relief can shield animals from view; vegetation, particularly trees and shrubs, can hide or camouflage animals.
- Observation conditions - adverse weather, including precipitations, fog, or haze, and "bumpy" air can reduce observation efficiency; snow cover generally provides much improved observability.
- Number of observers - use of the aircraft pilot as observer for one side of the transect is less effective than two dedicated observers.
- Double-counting - movement of animals between sample flights or flight lines; contrast this bias with flightline spacing bias.

- Daily and seasonal activity patterns - animal behavior patterns may affect observation efficiency, for example diurnal use of wooded and shrubby habitats where animals are camouflaged or completely hidden from view; or seasonal herding behavior wherein groups are easier to detect than individuals.

In addition to the aerial surveys, big game habitat preference data were collected opportunistically on the ground. The biggest difficulties with this type of data are the lack of control over uniformity of coverage of the area, inability to define the relative level of sampling effort expended by habitat type, and the observability biases related to diurnal and seasonal activity patterns of the animals and accentuated difficulties with topographic and vegetation visibility barriers.

Therefore, the following big game descriptions emphasize indices of abundance and herd composition available from Western Enery's aerial survey data base and rely more heavily on published literature for general information on big game habitat requirements.

a. Antelope

Over the eight years that intensive big game investigations have been conducted in the Colstrip vicinity, the pronghorn antelope (Antilocapra americana) has been consistently the most numerous big game species (Ecological Consulting Service, 1973, 1974, 1975; ECON, 1976, 1977, 1978, 1979; Western Energy, 1980). The Wildlife Study Area does not have large tracts of preferred pronghorn habitat, big sagebrush-grassland. Shrub-grassland habitat is particularly important to pronghorns during the winter months when sagebrush may represent over three-quarters of total forage intake, and the relative scarcity of this habitat in the Wildlife Study Area accounts for the substantially reduced pronghorn population in the area during winter. Since grassland is the predominant habitat, the area is favorable for antelope use in spring, summer, and fall.

Productivity of the pronghorn herd in the study area as reflected in fawn/doe ratios has been similar to estimates for production in game management units in the region. Observations per hour (Table 1, Appendix H) indicate severe winter die-off for the 1978-79 winter. The fawn/doe ratios indicate increased survival subsequent to this decline. Suitable habitat is available in Area C for pronghorn fawning.

Pronghorn observations for Area C follow the same general pattern as the Wildlife Study Area as a whole. Pronghorn observations are generally common in spring, summer, and fall when use of grasslands and agricultural areas predominates, but infrequent during the winter months, although an occasional small herd may remain in the vicinity of Area C during mild winters. These wintering pronghorn range over suitable habitats in the upper East Fork Armells Creek, Upper Lee Coulee, and Stocker Creek drainages (Western Energy, 1980).

b. Mule Deer

Mule deer (Odocoileus hemionus) are widely distributed over the Wildlife Study Area. Although deer forage in open grassland and agricultural fields, particularly in spring, they show a marked preference for timber-grassland and shrub-grassland habitat types during all seasons. These types are particularly important for forage and shelter during the harsh winter months, especially when snow cover restricts availability of low-growing forage. Although there is fairly consistent mule deer winter use of the eastern end of the Greenleaf Ridge, there generally are no large winter concentrations of deer observed in the Wildlife Study Area (Western Energy, 1980). Moister creek/coulee bottom habitats are often favored by foraging deer in summer and fall. Timber and shrub habitats are more common in the rougher terrain of the northwest and north-central portions of the Wildlife Study Area, including the high land to the north of Area C and drainages leading northward into Stocker Creek (ECON, 1981).

The deer population in the area has undergone a substantial reduction since the early studies were conducted in 1974 as reflected in the number of observations per hour of aerial survey time (Table 2, Appendix H). The reason for the reduction in deer in the area is not entirely clear, although severe winters in 1977-78 and 1978-79 contributed (ECON, 1977, 1978; Bureau of Land Management, 1981). The impediment of snow combined with a prolonged and sometimes drastic reduction in quantity and quality of available forage frequently accounts for large-scale winter die-offs (Wallmo and Regelin, 1981). It is not known to what extent legal and illegal hunting and other human activities may have contributed to the overall decline in deer numbers; some increase in both types of hunting is an inevitable consequence of population growth in the area over the past decade.

c. Other Big Game Animals

The only other big game animals reported in the study area have been white-tailed deer (Odocoileus virginianus) and elk (Cervus elaphus). Such observations are infrequent since the area does not support a sizable number of white-tailed deer and no permanent elk population.

2. Other Mammals

Small mammals in the Colstrip area include bats, shrews, rabbits and hares, and numerous rodent species (see Table 3, Appendix H). Small mammals provide an important prey base for mammalian predators and for raptors. The black-tailed prairie dog is a species of concern in Montana (Flath, 1981). Additionally, prairie dog towns provide habitat for an endangered species, the black-footed ferret. Other mammals that have been observed in the area include porcupines and chipmunks, which inhabit conifer/shrub habitat, cottontails and marmots in rocky areas, and muskrats, which are found in stock ponds and Castle Rock Reservoir. No population estimates have been made for these species in the area.

3. Mammalian Predators

The most common large mammalian predator in the Colstrip area is the coyote (Canis latrans), with badger (Taxidea taxus), red fox (Vulpes vulpes), and bobcat (Felis rufus) seen infrequently (Western Energy, 1980). Habitats found in Area C could be used by all these large predators. Coyotes and red foxes range widely across open brushland, woodlands, and farmland; badgers prefer grassland, brushy areas, and disturbed sites; and bobcats prefer forested and shrubby areas like those found in the north-central part of Area C (Whitaker, 1980). Weasel and skunk have also been observed in the area. Mammalian predators known in the area are shown in Table 3, Appendix H.

4. Upland Game Birds

Sharp-tailed grouse (Pedioecetes phasianellus) are the most numerous native upland game bird in the Colstrip vicinity. Sharp-tail dancing grounds are fairly evenly distributed across the Wildlife Study Area; twenty dancing grounds were active in the area in 1980 (Western Energy, 1980). Eight years of sharp-tail investigations in the Colstrip vicinity have shown fairly consistent numbers of grouse in the area, with variable attendance at individul dancing grounds. During the years of study, some grounds were abandoned, while other, new grounds were apparently established (ECON, 1975, 1976). The Area C vicinity has three dancing grounds (numbers 8, 25 and 35; Western Energy, 1980) with dancing ground 8 being the only ground within Area C, Block I boundary (T1N, R40E, S1, SE1/4, SW1/4). Dancing grounds tend to be open, sparsely grassed areas, often on knolls or ridges, and nesting habitat is generally shrub-grassland and ungrazed or lightly grazed grassland with good ground cover typically within about one-half mile of the dancing ground (Hillman and Jackson, 1973). Upland habitat types are preferred by sharp-tailed grouse. Moderately dense grass or grass-shrub cover provides shade and protection from detection by predators. Small grain fields in Area C are an important supplementary food source.

Ring-necked pheasant (Phasianus colchicus) crowing counts have been conducted since 1975 in the Wildlife Study Area. The main concentration area for pheasants is in the East Fork Armells Creek drainage primarily in the rail loop track-Colstrip area; overall, the study area is marginal pheasant habitat as reflected by fairly low call count results. Barley and wheat plantings and a winter feeding program enhance pheasant survival and production in the vicinity of the rail loop track (Western Energy, 1980).

Lesser numbers of Hungarian (Gray) partridge (Perdix perdix) and Merriam's turkey (Meleagris gallapavo) are found in the Wildlife Study Area. The Hungarian partridge is most often observed in reclaimed areas with good grass cover whereas turkeys are most often observed in grassland, shrub-grassland, and timber-grassland areas typically in the portions of the study area with rougher topography. Few partridge or turkey observations have been made in the vicinity of Area C.

Sage grouse (Centrocercus urophasianus) are not numerous in the Wildlife Study Area and have not been observed in Area C.

5. Waterfowl

Waterfowl recorded in southeastern Montana, including the Wildlife Study Area, are included in Table 4, Appendix H. Several of these waterfowl are considered of high federal interest (Spear, 1980). Of these species, only the canvasback has been reported in the study area (ECON, 1979). Most waterfowl observations are associated with Castle Rock Reservoir, Area A sediment pond, East Fork Armells Creek, and several small stock impoundments. Area C does not presently have adequate available surface water to attract concentrations of waterfowl, however limited nesting habitat is available in Area C.

6. Songbirds

The Migratory Bird Act of 1973 (16 USC 703-711) placed most songbirds in the United States under federal protection. Table 4, Appendix H shows songbirds expected in the Colstrip area on the basis of published reports, and notes those observed as part of the Wildlife Study Area investigations (Ecological Consulting Service, 1973, 1974, 1975; ECON, 1976, 1977, 1978, 1979; Western Energy, 1980). Most of the observed songbirds have been species commonly associated with grasslands or with open pine forests, both found in Area C. No songbird species observed in the study area is listed as threatened or endangered (Federal Register, 1980). No songbird species of federal interest (Spear, 1980) have been recorded in the Wildlife Study Area, although it is within the range of and suitable habitat for several. State species of special concern that have been observed in the area include eastern bluebird (Sialia sialis) and western bluebird (Sialia mexicana).

7. Raptors

The most common raptors in the Colstrip area are the red-tailed hawk (Buteo jamaicensis), American kestrel (Falco sparverius), and harrier (Circus cyaneus) (Bricco, 1981; ECON, 1979). Other common raptors are the great horned owl (Bubo virginianus), prairie falcon (Falco mexicanus), and golden eagle (Aquila chrysaetos) (Martin, 1981; ECON, 1979; Western Energy, 1980). Table 4, Appendix H includes raptors expected to occur or actually observed in the study area.

Although all raptor species are federally protected, there are several known from the Wildlife Study Area that have been given special status by Montana (Flath, 1981) or the federal government (Spear, 1980; Federal Register, 1980). These species are discussed briefly in the following paragraphs.

Golden eagles and bald eagles are protected by the Bald Eagle Protection Act of 1940, as amended in 1962 (16 USC 668a). Golden eagles are observed fairly often in the Colstrip area, and have nested on a

sandstone cliff in Area C as recently as 1978 (ECON, 1978, 1979). In all, three golden eagle nest sites, two on sandstone cliffs and one in a ponderosa pine, have been identified in the study area. Rabbits and rodents are usually the primary food of golden eagles (Peterson, 1961), but during studies of sharp-tailed grouse in the Colstrip study area (ECON, 1976, 1977), several of the radio-tagged grouse were taken by golden eagles.

Ferruginous hawk (Buteo regalis) was observed in the northern part of Area C during a 1978 bird survey (ECON, 1978), and is listed as a species of high federal interest (Spear, 1980). Ferruginous hawks may nest in trees, on cliffs, or on the ground in open rangeland, and have been known to feed on prairie dogs and ground squirrels (Udvardy, 1977).

Prairie falcons (Falco mexicanus), considered of high federal interest (Spear, 1980), are fairly common in the Colstrip area; four active prairie falcon nests were recorded in the study area in 1980 (Western Energy, 1980). These birds nest on cliff ledges and eat ground squirrels, other rodents, and songbirds in open country (Udvardy, 1977). A prairie falcon nest is located on the same sandstone outcrop in Area C as the golden eagle nest. These falcons are of special interest in the Colstrip area because of the number of known nests and occupied territories.

The burrowing owl (Speotyto cunicularia) was observed in the southwest corner of Area C in 1979 (ECON, 1979), is of high federal interest (Spear, 1980), and is thought to be declining in Montana (Bricco, 1981). This owl lives in burrows deserted by species such as prairie dogs or badgers, and hunts rodents, mostly by day. Considerable grasslands and scrublands in Area C provide suitable habitat for burrowing owls.

Several species of raptors observed during Rosebud Mine Wildlife Resource Studies are listed as species of special concern in Montana (Flath, 1981). These species are Cooper's hawk (Accipiter cooperii), ferruginous hawk, golden eagle, bald eagle, prairie falcon, merlin, burrowing owl, and long-eared owl (Asio otus).

8. Reptiles and Amphibians

No specific surveys have been made for reptiles or amphibians, but incidental sightings have been noted in the annual wildlife surveys at the Rosebud Mine (Western Energy, 1980). Prairie rattlesnake (Crotalus viridis) sightings were mentioned every year from 1976 through 1980. Bull snake (Pituophis melanoleucus) sightings were mentioned each year from 1977 through 1980. Other reptiles and amphibians mentioned in the annual wildlife survey reports included snapping turtles (Chelydra serpentina), painted turtle (Chrysemys picta), sagebrush lizard (Sceloporus graciosus), hognose snake (Heterodon sp.), racers (Coluber constrictor), salamanders (Ambystoma sp.), and frogs.

Table 5, Appendix H lists reptiles and amphibians expected to occur in southeastern Montana (Stebbins, 1966), and notes observations in the Rosebud Wildlife Study Area between 1976 and 1980 (ECON, 1976a, 1977a,

1978, 1979; Western Energy, 1980). Turtles, salamanders, and frogs are not likely to be common in Area C since they require a wet habitat. Hognose snakes, of special concern in Montana (Flath, 1981), may be present, especially in farmland in Area C. Prairie rattlesnakes inhabit virtually all of the habitat types present in Area C (Stebbins, 1966; ECON, 1981).

9. Threatened and Endangered Species

Bald eagles (Haliaeetus leucocephalus) (ECON, 1979) and a peregrine falcon (Falco peregrinus) (Martin, 1981) have been observed in the Wildlife Study Area during migration. These two birds are listed as endangered species (Federal Register, 1980); however, no critical habitat for either bird is known to be present in the Colstrip area. No specific studies for these species were conducted.

Because the endangered black-footed ferret (Mustela nigripes) is largely dependent on prairie dogs for food, the possibility of black-footed ferrets being present must be considered. There are not records of black-footed ferrets in Rosebud County. The only known prairie dog colony, approximately 100 acres in size, is north of Area C in the Stocker Creek drainage. In 1978 and 1979 the colony was inspected for black-footed ferret signs. Additionally, a black-footed ferret spotlight survey was conducted in 1979. None of these surveys revealed evidence of black-footed ferrets (ECON, 1978, 1979).

I. SOCIOLOGY AND ECONOMICS

1. Economic Conditions

Traditionally, agriculture has been the primary economic activity in Rosebud County, but during the past decade, agriculture has been declining in relative importance. The county is undergoing a transition from an agrarian economy to an economy primarily dependent on energy development. This fact is supported by substantial increases in personal income and employment for energy-related activities and a corresponding decrease in agricultural income and employment. All statistical data presented in the following subsections were derived from the Bureau of Economic Analysis, U.S. Department of Commerce.

a. Personal Income

Over the past decade, labor income has been the most significant contribution to total personal income in Rosebud County, more so than in the state of Montana as a whole. Labor and proprietors' income (sometimes called participation income) accounted for about 84 percent of total personal income during 1979 in Rosebud County and approximately 73 percent in Montana. In 1970, the corresponding figure was about 79 percent for Rosebud County and 78 percent statewide.

Table 1, Appendix I presents personal income by major source for Rosebud County and Montana during 1970 and 1979. Annual data for Rosebud County are shown in Table 2, Appendix I. These figures were converted to constant 1980 dollars.

In 1979, agriculture accounted for only 2.7 percent of total personal income, compared to 18.7 percent in 1970, however, mining and construction have shown sizable gains. In particular, mining increased from 3.9 percent of total personal income in 1970 to 20.9 percent in 1979. Despite the downward trend, the relative importance of agriculture in Rosebud County continues to be slightly greater than the figure for Montana. However, the relative importance of mining employment in Rosebud County is more than four times the figure for Montana.

Per capita income figures for Rosebud County and Montana from 1970 to 1979 are presented in Table 3, Appendix I. Per capita income is equal to total personal income divided by population; in other words, it is average income per person. In order to correct for inflation, per capita income was converted to constant 1980 dollars.

Per capita income in 1979 for Rosebud County was $6,948 (1980 dollars), or about 19 percent below the Montana average of $8,601 (1980 dollars). During the 1970s, real per capita income in Rosebud County grew at about the same rate as in Montana; between 1971 and 1979 it rose 26.5 percent in Rosebud County and 26.4 percent statewide. The stability of real wages in the county from 1970 to 1979 indicates that Colstrip Units 1 and 2 did not cause significant increases in labor costs to local businesses (Polzin, 1981). Per capita income in Rosebud County was much

more variable than in Montana during the 1970s, reflecting the wages paid during the construction of Colstrip Units 1 and 2, and the fact that agricultural income is highly cyclical.

b. Employment

As shown in Table 4, Appendix I, total employment in Rosebud County rose from 2,465 in 1970 to 4,472 in 1979, an increase of about 81.4 percent. Annual data for Rosebud County are presented in Table 5, Appendix I. In Montana, total employment increased from 279,091 to 373,409, or 33.8 percent during the same period.

The decline of agriculture and manufacturing, and the rise of mining, services, construction, government, transportation, and public utilities employment is evident, as shown in Table 4, Appendix I. In 1970, agriculture was the largest employer, but by 1979, both services and government employed more people.

Labor market trends may also be analyzed in terms of employment in basic and derivative industries. Basic industries depend on nonlocal markets or are otherwise influenced by factors originating outside the area. Derivative industries, on the other hand, serve the local population. Economists believe that changes in basic industries lead to further changes in derivative industries. Employment data for Rosebud County have been organized into basic and derivative categories, presented in Table 6, Appendix I. The decreasing relative importance of agriculture and the increasing importance of mining, construction, transportation, and public utilities to the economic base of Rosebud County is reemphasized by this data.

2. Demographics

The 1970 and 1980 populations of Colstrip, Rosebud County, and Montana are presented in Table 7, Appendix I. Estimates of the populations of Colstrip and Rosebud County have been used rather than census figures to more accurately present actual growth in the area. The timing of the census and the boundaries of some census enumeration districts distorted the count of actual area residents. Population estimates were developed by Western Analysis, Inc. (1982), based upon actual area employment and population employment multipliers. The populations of Colstrip and Rosebud County increased dramatically during the 1970s; Colstrip's 1980 population was more than 13 times as large as its 1970 population. The Rosebud County population nearly doubled during the same period. By comparison, the population of Montana increased 13 percent between 1970 and 1980 (U.S. Bureau of the Census, 1981).

A comparison of age and sex compositions of the 1970 and 1980 Colstrip and Rosebud County populations is shown in Table 8, Appendix I. A comparison of age cohorts expressed as a percentage of total populations is presented in Table 9, Appendix I for Colstrip and Rosebud County populations. The age composition of both populations has shifted toward the younger adult age groups (23 to 44), with corresponding decreases in

the proportions of older adults. This phenomenon is more pronounced in the Colstrip population, where the age 25 to 34 cohort proportion of the population has doubled during the decade. Slight increases in the proportion of younger children (ages up to nine) also occurred in the Colstrip population. The sex ratios of Colstrip and Rosebud County populations show a slight surplus of males in 1970. In 1980, the surplus of males in the Colstrip population had increased ten percent; a much smaller proportionate increase in males occurred in the Rosebud County population.

3. Baseline Economic/Demographic Forecast

Table 10, Appendix I contains the annual employment, population, and per capita income forecast for Rosebud County. Similar quarterly information is presented in Table 11, Appendix I. Table A, Appendix I presents the personal income projections for Rosebud County.

As displayed in Table 12, Appendix I, per capita income in Rosebud County is projected to increase during the construction of Colstrip Units 3 and 4 and then return to normal levels by 1985. Per capita income is projected to increase from $7,986 (1980 dollars) in 1980 to $9,090 in 1983, then to decrease to $8,250 by 1985. Beyond 1985, real per capita income is projected to grow throughout the forecast period.

Total employment and population for Rosebud County and Colstrip are expected to peak the fourth quarter of 1982, then decrease until 1990, then increase through 2010 and then decrease thereafter as illustrated in Tables 10 and 11, Appendix I. Peak basic employment, total employment, and population for Rosebud County are 6,001; 8,414; and 16,913 persons, respectively. Colstrip population is expected to peak at 7,665 persons in the baseline forecast. Nonbasic employment is forecast to increase through 2010 and then decrease thereafter.

Between 1980 and 1985, basic employment, total employment, and population follow the construction cycle of Colstrip Units 3 and 4. Turbine roll is expected the fall of 1983 for Unit 3 and the fall of 1984 for Unit 4 (Kelley, 1982). Between 1990 and 2010, basic employment, total employment, and population in Rosebud County and Colstrip are forecast to increase due to basic growth in the trade, services, and nonfarm proprietors industries. The service industry in particular experienced significant growth after the completion of Colstrip Units 1 and 2 and is expected to continue to expand throughout the forecast period. It was assumed in the report that coal mining in Rosebud County would cease after 2018.

Despite a projected decrease in agricultural employment, agriculture will continue to have an important role in Rosebud County as a large employment category and source of personal income. Agricultural experts are optimistic about the outlook for both grain and cattle during the coming decades. The trend toward larger and more capital-intensive farms and ranches should continue. The Rosebud economy will, however, become less dependent on agriculture and more dependent on energy development during the baseline forecast period.

4. Social Life

a. Social History

The earliest nonmilitary white settlers in the Rosebud County area were range livestock operators, who began to arrive in 1876. Population growth in the area was gradual until the siting of the Northern Pacific Railroad in 1882, when access and immigration to the area increased. Economic activity in the area was agricultural or tied to the railroad (Western Historical Publishing, 1907). Agriculture and derivative service employment remain the primary economic activity in Rosebud County, except for the Colstrip area.

The presence of a company town and industrialization in the Colstrip area are not new phonomena. Colstrip was developed as a company town after coal strip mining was initiated in 1924 by the Foley Brothers, on contract to Northern Pacific. During this initial mining period, Colstrip evolved into a community center serving agriculture and industry. The Colstrip School became a focal point of community and social activities for area residents. The maximum area population during this mining period appears to have been about 550 residents in 1950 (Douglas, 1982). Mining ceased in the area in 1958 when diesel engines replaced steam locomotives. After mine closure, the residual population comprised a maintenance crew for the mine properties, school personnel, and ranchers (Rosebud County Bicentennial Committee, 1977). The town has continued to serve as a primary social focal point for the surrounding area, until large-scale coal and energy development resumed.

Mining operations were resumed in 1968 by Western Energy, a subsidiary of Montana Power Company, followed closely by construction of power plants and additional mines in the area. The population of Colstrip jumped from 250 in 1970 to about 1,500 in 1972. The population peaked during the 1970s at an estimated 2,800 people in 1975, during construction of Colstrip Units 1 and 2 (Rice, 1982). The present population is estimated to be approximately 5,800 (Western Analysis, Inc., 1982).

The scale of recent energy development in the Colstrip area was a phenomenon to the area's residents and intensified conflicts between agricultural and industrial interests. Sources of conflict have included resource development and land management issues, economic impacts of industrialization upon agriculture, loss of political influence and community identity among long-time area residents, and differing value systems (Gold, 1974, 1975).

A recent survey was conducted by Western Analysis, Inc. (1982) to characterize social life in the Colstrip area. The information presented in the following sections addressing the social life of Colstrip was drawn from three sources. Those sources were:

- Lengthy personal interviews of 31 Colstrip and Rosebud County residents who were selected on the basis of their reported knowledge of the study area

- o A quality of life survey of 243 Colstrip households conducted by Western Analysis (1982)

- o Various statistical reports published by federal and state agencies

The items discussed below are distinct definable characteristics of most human groups, whether communities or aggregations. These characteristics can be and are used to describe the social life of human groups. They also can be and are used to indicate change and the effects of change in the social life of human groups.

b. Community

Colstrip remains a company town. Decisions regarding development of Colstrip are made by the Montana Power Company. A recent voter initiative to incorporate Colstrip as a self-governing municipality was defeated. Reportedly, only a small proportion of the present town residents identify themselves with Colstrip or consider Colstrip "home." Those Colstrip residents who predate the recent development boom and comprised the Colstrip community are fewer in number and are submerged within the larger, "new" Colstrip. The ranching community, traditionally the dominant group in the Colstrip area, reportedly has severed most ties with Colstrip and exists as a parallel (and diminishing) community outside its bounds. According to area informants, relatively few residents of Colstrip know any member of, or have much in common with the ranching community. Further, few Colstrip residents reportedly possess ties to, or interest in the remainder of Rosebud County. Most present residents of Colstrip are said to identify themselves most strongly with their occupations or employers.

Several characteristics of Colstrip appear to have inhibited its development as a social community: its status as a company town, its rapid growth, and the large number of temporary jobs available. Community is defined as a human population living within a limited geographic area and possessing an interdependent life under common cultural and institutional regulations. Virtually all decisions concerning community development rest in the hands of persons not elected by the residents. The costs of improvements to city properties are borne in large measure by Montana Power Company. The physical structure of new parts of the city developed in response to company plans, rather than to pressures from the residents. In the early stages of city development, housing shortages resulted in segregation of residents by employer (Western Energy, Montana Power Company, Bechtel, and Long Construction) and by type of employment (blue collar or white collar). The rate and degree of growth overwhelmed the older, existing community. Many newcomers reportedly were from urban, industrial areas and had little in common with the existing, particularly rural, residents. Finally, the short-term nature of many jobs discouraged the development of community identification.

The consensus of informant opinion suggests that Colstrip has not yet regained a true community identity as defined above. Further, these

residents suggest that a community identity cannot be formed until the transient construction and management crews depart upon completion of Colstrip Units 3 and 4. Despite this, the basis of a Colstrip community exists and is comprised of those residents who have remained in Colstrip for several years, are employed in permanent jobs, and intend to remain in Colstrip.

c. Social Structure in Colstrip

City residents consistently divided the Colstrip population into three major groups:

- Transient workers, usually craftsmen, but also including some supervisory personnel.
- Technicians/operators, usually employed in permanent jobs, who have been in Colstrip more than two years and intend to stay.
- Management/high level supervisory personnel, usually employed in permanent positions, but including some long-term temporary personnel (e.g., Bechtel personnel).

Area informants stated that school personnel formerly had constituted a fourth group, but now are being assimilated within the management and technical/operators groups.

Twenty-two formal social organizations in Colstrip list their meeting dates in the local newspaper. City informants state that these groups constitute the primary social organizations in the area, although other, smaller, and very informal organizations also meet from time to time. Of the organizations listed, nine exist for recreational purposes. Four youth organizations (scouting) are listed. Three organizations have community service functions: the PTA, the Women's Club, and Parents Against Drug Abuse. A fourth group of a similar type, addressing the problem of spouse abuse, reportedly is being organized. Only two organizations appear to serve purely social or fraternal purposes. The remaining groups are concerned with alcoholism, obesity, commercial matters, and governance of the local library. Religious groups also exist in Colstrip, in connection with approximately ten church congregations.

Area informants state that membership in the formal social organizations is a matter of personal interest. Reportedly, none of the organizations is exclusive except the commercial and fraternal ones. Despite the nonexclusive policies of these organizations, temporary residents reportedly are far less likely to join than the permanent residents. Most organization members are said to be from the technician/operators social group, which is the larger of the two groups comprising the more permanent residents of Colstrip.

d. Social Interaction in Colstrip

Social interaction between individuals and groups in Colstrip reportedly is now less dependent upon occupation or employer than in previous years. As mentioned in Section b. (Community), during the initial population boom period engendered by construction of Colstrip Units 1 and 2, a housing shortage forced segregation of residents by company and reportedly by occupation (white collar and blue collar). As a consequence, most social interaction in Colstrip is between employees of the same companies and within like occupational groups. This segregated social interaction is further strengthened by company practices that provide social and recreational activities for company employees only. More recently, in some instances Western Energy has allowed residents to purchase company-built houses as they have become vacant. This situation has broken the earlier, segregated housing pattern and has made social interaction across company and occupational lines more possible among homeowners.

A substantial majority (more than 70 percent) of Colstrip survey respondents indicated that Colstrip residents are friendly, helpful, and sociable. Over 50 percent of respondents indicated that it is easy to get to know people in Colstrip, that length of residence and income have little effect upon community acceptance or influence, that the more long-term residents are friendly. However, one's occupation does affect his influence within Colstrip, according to more than 50 percent of the residents. The perceived occupational distinction is drawn between white collar and blue collar workers. Some blue collar workers are as well paid as white collar workers, but have less influence within Colstrip. A plurality of respondents (45.1 percent) indicated that there is "some" or "a great deal of" status consciousness in Colstrip.

Colstrip informants agreed that residents in Colstrip townsite are friendly and added that social interaction across occupational and company lines is increasing. Nevertheless, social interaction reportedly remains somewhat bound by occupation, and to a lesser degree, by employer. Length of residence in Colstrip and the permanence of one's job often were identified as influences that govern the likelihood of social interaction. Those who hold permanent or long-term jobs are more apt to socialize and to do so across company lines. Those employed in temporary positions are less apt to socialize. Further, craftsmen employed in temporary positions reportedly are apt to socialize almost exclusively with other members of their own craft, rather than with all crafts at a given site.

The apparent selectivity of social interaction in Colstrip among the more permanent residents reportedly is determined more by opportunity than by intent. Conversely, patterns of interaction among craftsmen reportedly are by choice. Nonetheless, many informants stated that there are many lonely people in Colstrip and added that loneliness in Colstrip can be particularly intense, given the town's isolation and limited recreational facilities. Some Colstrip residents reportedly do not interact with others.

e. Colstrip Lifestyle

Colstrip informants were unable to describe a uniform "Colstrip lifestyle," but did identify several common characteristics of life in Colstrip. Informants agreed that life in Colstrip has little in common with the remainder of Rosebud County or with Colstrip before coal development resumed. Due to a high degree of turnover in crafts employment, the job market in Colstrip reportedly is quite good and the population of the town is in a state of flux. The proportion of workers earning relatively high wages is greater in Colstrip than in the surrounding area. The minimum salary for non-clerical personnel at the MPC and Western Energy operations in Colstrip is roughly $400 to $450 per week. There are very few low income or unemployed people in Colstrip. There are very few organized recreational opportunities and facilities in Colstrip, relative to the size of the population. Although many informants insist there is plenty to do in Colstrip, they also indicated that many residents are bored, in part because they are not accustomed to entertaining themselves. Boredom reportedly accounts for the heavy consumption of alcohol that is said to be characteristic of Colstrip residents and for the exodus from Colstrip each weekend. Unemployed wives are said to be especially bored with life in Colstrip.

Distinctions are drawn between the lifestyles of transient (primarily crafts) residents and the more permanent technicians/operators. The latter are said to be more home- and family-oriented and to lead more routine, predictable, and community-oriented lives. The transient residents are said to lead less stable, less home-oriented lives, and to display less interest in the community. Temporary crafts employees very often were characterized as leading "work hard, play hard" lives. Temporary employees also were described as less apt to have families in Colstrip and to be less family-oriented.

Most informants agreed that life in Colstrip can be inconvenient and stressful to those accustomed to more urban environments. Colstrip is isolated, has very few commercial resources for its size, and very few outlets for those not employed. Although a community recreation center does exist (and is well used), and a small women's welcoming club serves newcomers, Colstrip's infrastructure provides very few opportunities for casual social interaction. Further, there is very little public land in the immediate area for recreational purposes.

f. Values

Colstrip informants who predate the resumption of coal development (about 30 percent of those interviewed) distinguish between the values of the newer residents of Colstrip and those who were in residence before redevelopment. Pre-redevelopment residents were said to value family, community, neighbors, hard work, frugality, and an independent, self-reliant approach to life. Post-redevelopment residents are described as placing less emphasis upon community, neighbors, frugality, and work for work's sake; and more emphasis upon money, materialism, and more immediate gratification of wants. Colstrip informants also draw distinctions between the values of temporary and more permanent residents. The more

permanent residents are said to place a higher value on home and family life and upon what the informants labeled as a stable, responsible, and predictable lifestyle than do the more temporary residents. The temporary residents were described as valuing community life and stability the least of all Colstrip groups and as placing higher value upon material goods and immediate gratification of wants.

Education reportedly is no longer a value among Colstrip's children. This circumstance is said to be strikingly different from pre- and early redevelopment periods in Colstrip's history. Reportedly, a large number of students regard an education as less important, particularly in light of their assumptions that quite lucrative jobs will be available to them in the construction industry at Colstrip and elsewhere without an education. Colstrip informants were in general agreement that although most residents appear to value education primarily as an economic tool, the attitude of children toward education distresses most parents. The informants were not able to state with any consistency whether the children's perceptions of education were influenced by their parents' lifestyles or occupations.

g. Conflict

There is little overt, formalized conflict between social groups in Colstrip, according to informants. Conflict between the rural agricultural community and the Colstrip coal community no longer is as visible as in the early and mid-1970s. Specific objections to specific aspects of coal development are still made by members of the agricultural community, but the opposition reportedly lacks the scope and intensity of that in previous years. Conflicts concerning trespass largely have been resolved through formal, legal channels; in addition, a deputy is now assigned to patrol the rural areas adjacent to Colstrip.

Conflicts within and between temporary and permanent groups apparently exist on an individual, informal basis. Several informants suggested that the Colstrip population is so diffuse and fluid that there has been no opportunity for conflicting groups to develop. Individual conflicts within the transient population reportedly are resolved through mutual avoidance, or in a few cases, through overt conflict; whereas avoidance of overt conflict reportedly is the mode of choice of the city's residents. Some conflict over construction of new schools and the busing of children to the schools has arisen recently. In this instance, no coherent, formal, group-based positions have developed as yet.

Area informants uniformly state that Colstrip residents are remarkably apolitical. Many stated that the residents are too passive politically. County elected officials have stated that development in Colstrip has not resulted in identifiable or attributable shifts in the political balance of the county.

h. Religion

There are ten active churches in Colstrip, some of which reportedly have very small congregations. The congregations are described as being evenly divided between mainline and fundamentalist orientations. There reportedly is little ecumenical spirit among the various congregations; the ministerial association is said to have collapsed from lack of interest. A plurality (45 percent) of Colstrip survey respondents indicated that some or few residents attend church regularly; 21 percent of respondents did not know whether residents attend church or not. One minister suggested that perhaps 15 percent of town residents attend church regularly. Informants suggested that permanent residents were more apt to attend church than transient residents. Over 70 percent of survey respondents considered religious activities to exert an average or minor influence on community affairs. Nearly 22 percent had no idea of religion's influence on community life.

i. Family Life

Family life reportedly is very important to most residents who have families. Sixty-seven percent of surveyed residents have children living at home; an average of two children reside in those households with children living at home. Colstrip informants suggested that life in Colstrip exerts a very strong influence on families. Whether this influence is positive or negative depends upon the nature of the family. If a family is close and "healthy," life in Colstrip can exert a positive influence. Conversely, if the family is "unhealthy" or unstable, life in Colstrip reportedly can exert a very negative influence. Family problems reportedly include spouse abuse, child neglect and, less often, child abuse, excessive drinking, marital infidelity, and divorce. No reliable data were available to substantiate these perceptions. Several informants and social service professionals described Colstrip as a testing ground for family life. The limited availability of recreational and other alternatives to family life forces family members to spend more time together and thereby intesifies the strengths and weaknesses of family relationships.

j. Social Problems

Divorce, family instability, and drug and alcohol abuse were mentioned consistently as the major social problems in Colstrip. However, law enforcement officials indicated that the incidence of major crimes in the area was surprisingly low and added that the majority of crimes with which they deal are petty crimes (Ash, 1982). Various statistics support some of these perceptions, although such statistics may be compromised in part by the presence of the Northern Cheyenne Indian Reservation within the county. Indian reservations often have high rates of alcoholism, divorce, crime, illegitimacy, teenage pregnancy, family instability, suicide, death, and morbidity. The presence of the Northern Cheyenne Reservation in Rosebud County <u>may</u> raise the level of some of these indicators at the county level.

Alcoholism rates (as measured by admissions to institutional treatment programs) are nearly three times higher in Rosebud County than in Montana. The rate of out of wedlock births in Rosebud County is nearly twice the state rate. Comparative rates of admissions to the state mental hospital were much higher in Rosebud County than in Montana (over twice as high) in the years 1970 through 1974, but were lower than the state rate after those years. This statistic may be compromised by the greater availability of community mental health programs (which divert patients from institutional treatment) in the rest of Montana and the much more stringent statutory criteria for admission to statewide institutional treatment facilities. Contrary to community perceptions, the divorce rate in Rosebud County has been consistently below the corresponding state rate since 1970. No data are available to refute or support the perceptions of informants and service professionals that spouse abuse and child neglect are problems in Colstrip.

5. Social and Community Services

a. Law Enforcement

Law enforcement in Colstrip is provided by the Rosebud County Sheriff. The sheriff's jurisdiction in Colstrip includes all areas except the generating station and construction sites. Six deputies, five dispatchers, and one dogcatcher are assigned to the Colstrip office. An additional deputy patrols the rural area south of Colstrip to Ashland. All deputies are graduates of the Montana Law Enforcement Academy. Law enforcement personnel and equipment are located in the Colstrip Community Service Center. Detention facilities, located in the same building, comprise four cells, each with two bunks. The cells are arranged to provide segregation of prisoners by sex and by age. The Colstrip detention facility is used only as a holding facility, pending adjudication of prisoners. Persons sentenced to jail terms are transferred to Forsyth. The Colstrip office is provided with three patrol cars and one pickup truck. Communications are provided by a low frequency band radio system, with transceivers in each motor unit. The sheriff's office provides communications and dispatching services for the local emergency medical service and fire protection organizations.

All vehicles within the sheriff's fleet are replaced on a planned and budgeted biennial schedule. The detention and office facilities were constructed in 1976, and are in excellent condition. The office's radio equipment is also in good condition and will require replacement in the near future only if Montana law enforcement agencies change to high-frequency equipment. The sheriff considers his manpower and equipment to be adequate to serve the present population (Ash, 1982). Over 60 percent of surveyed residents considered law enforcement services to be good to average.

b. Fire Protection

Fire protection services in Colstrip are provided by a 22-member volunteer fire department. Only the chief is certified at present. All

volunteers are in training and are expected to be certified within six months. Fire flows in Colstrip are considered adequate for present and future needs and are expected to improve with scheduled modifications of the city water distribution system. The fire department is equipped with the following:

- One 1957 International Harvester 1,000-gallon pumper
- One 1980 Superior 1,000-gallon pumper
- One 1972 International Harvester 1,500-gallon tanker with a 300-gallon-per-minute pump

An additional 1,000-gallon pumper will be purchased and should be delivered by the fall of 1982. Equipment storage is provided at the Colstrip Community Services Center and is considered adequate. A two-stall garage is to be constructed in the vicinity of the Pine Butte School in the northern end of Colstrip in the fall of 1982. The new fire truck will be stationed at that facility.

The fire station is located on the west side of railroad tracks that bisect Colstrip. An overpass on the northern end of town allows access to all areas of Colstrip in the event that the railroad crossings are blocked by a train.

The Colstrip fire chief considers his department adequate to meet the fire protection needs of Colstrip for the present and the foreseeable future. No plans have been made to replace any equipment in the immediate future (Durham, 1982). Fifty-five percent of surveyed residents considered fire protection services to be good to average.

c. Sanitary Sewer

Wastewater treatment in Colstrip is accomplished with an oxidation ditch facility. That system is to be supplemented by an aerated lagoon, which is to be installed at the site of an older, now unused three-cell lagoon system. The town's wastewater will be retained in the aerated lagoon for a ten-day treatment period, after which it will be discharged to the oxidation ditch. The remaining two cells of the old lagoon system are to be used as sludge drying beds (Mountain West Research, 1981). Although construction of the aerated lagoon was completed in January 1982, the lagoon has not been filled for fear that it will freeze. As a result, the oxidation ditch facility is operating at levels above its hydraulic capacity. The new lagoon will be filled as soon as the weather permits, at which time the combined system is expected to function properly. The new treatment system is considered adequate to meet the needs of the present and projected peak construction population of Colstrip (Miller, 1982). Over 73 percednt of surveyed residents considered sewer services good to excellent.

d. Water Supply

The Colstrip public water supply is drawn from Castle Rock Lake, a surge pond built to supply make-up water to the Colstrip electrical generating units. The water right to the water is held by the Montana Power Company. The lake is filled with water piped from the Yellowstone River. Two water treatment and distribution systems, with a combined capacity of 2,200 gallons per minute (gpm), serve Colstrip. One system, an upflow clarifier and filtration system, supplies 1,000 gpm. The other, a diatomaceous earth filtration unit, operates at 1,200 gpm. Three high-volume service pumps transfer treated water from a 30,000-gallon clearwell to the distribution system. Storage for treated water is provided by three reservoirs with a combined capacity of three million gallons. The present system is inadequate to meet projected peak demands. Western Energy is constructing an expanded water treatment plant that will include a 4,000 gpm direct filtration unit, a 390,000-gallon clearwell, a new high-volume pumping station, and an additional 680,000-gallon storage facility (Mountain West Research, 1981). The new system should be operating by April 1982, and will replace the two older systems. The 1,000-gpm upflow clarifier/filtration unit will be maintained as a peak demand backup unit. The new treatment system is considered adequate to meet the needs of the present and projected peak construction populations of Colstrip (Miller, 1982). Over 76 percent of surveyed residents considered the water supply to be good to excellent.

e. Solid Waste

Solid waste collection and disposal services now are the responsibility of Rosebud County, and are met by a rural refuse disposal district. The district is served by a three-man crew and is equipped with one truck with a 25-cubic yard compactor. Solid wastes are buried in old strip mine cuts that have been sealed with clay; old mine spoils are graded over the solid wastes. The present dump site serves Rosebud and Treasure Counties; the Northern Cheyenne Reservation reportedly also will use that disposal site in the near future. No capacity or groundwater contamination problems are foreseen at the current dump site for either the present or projected peak populations of the service area. Four groundwater quality monitoring wells have been installed near the dump site, and are checked at six-month intervals. Solid waste collection capacity is adequate at present, with one pickup-day per week. The cost of an additional collection unit has been estimated at about $55,000 (Tusler, 1982). Over 67 percent of surveyed residents considered local waste disposal service to be good to average.

f. Social Welfare

The social welfare programs provided by the Rosebud County Department of Public Welfare are identical to those available in all county offices in Montana. These programs include:

- Aid to Families with Dependent Children (AFDC)
- Medical Assistance (Medicaid and County Medical Assistance)

- o Foster Care
- o Food Stamps
- o Social Services (e.g., Homemaker Services, Meals on Wheels, etc.)
- o General Assistance
- o Transient Assistance

All of these services are available to Colstrip residents; however, some of the services must be obtained directly from the Forsyth office. The income status of most Colstrip residents precludes their eligibility for many programs; therefore, most services rendered in Colstrip are child protection services.

The Colstrip Community Welfare Office is staffed by one social worker, whose workload primarily consists of investigating referrals of child abuse or neglect, placing children in foster homes, supervising foster homes, and following up on AFDC cases (Polley, 1982). In 1981 (fourth quarter), there were 61 child protection cases in Colstrip (Gabel, 1982).

Colstrip reportedly is adequately staffed at this time. During the peak construction of Units 3 and 4, however, an additional social worker or paraprofessional will be required to meet Colstrip's expanded needs (Kennedy, 1982). Most survey respondents (75 percent) had no opinion of the adequacy of local welfare services.

g. Medical Services

The outpatient medical needs of Colstrip are served by the Colstrip Medical Clinic, a Southeastern Montana Rural Health Initiative (SEMRHI) clinic. Counties that are served by SEMRHI, namely Rosebud County, are considered medically underserved and are funded by a grant from the Department of Health and Human Services. The clinic's professional staff includes two general practitioners (one National Health Service physician and one contracted physician), two part-time registered nurses, and one x-ray technician (Catapano, 1982). There are three examining rooms, an x-ray unit, a laboratory, and a fully-equipped emergency room (Palm, 1982). The medical staff and facilities are adequate to serve the Colstrip community (Viall, 1982). Fifty percent of survey respondents considered local medical services to be good to average; 32 percent considered them fair to poor.

The Colstrip Dental Clinic and Optometrist are located in the same building (Colstrip Mall) as the Medical Clinic. There are two dentists, two dental assistants, and one dental hygienist (May, 1982). The optometric office staffs one part-time optometrist (two days a week) and an optometric assistant (Porter, 1982).

The Eastern Montana Community Mental Health Center of Miles City administers the Colstrip mental health services. The Colstrip Mental Health Center, which is staffed by one psychologist, handled approximately 50 cases in 1981 (Mountain West Research, Inc., 1981). The Mental

Health Center is at its maximum capacity now (Peterson, 1982). Over 60 percent of respondents had no opinion of the adequacy of these services.

There are four ambulances in Colstrip; two are owned by Bechtel Energy Company and two by the Colstrip Emergency Medical Service (EMS). Helicopter and fixed-wing air ambulance service is available through Saint Vincent Hospital in Billings. EMS is staffed by 11 volunteers, all of whom are either Emergency Medical Technicians (EMTs) or in EMT training (Kampf, 1982). This emergency service is adequate for current needs (Mountain West Research, Inc., 1981). Over 64 percent of surveyed residents considered emergency medical services to be good to excellent.

Rosebud Community Hospital in Forsyth is the closest hospital to Colstrip (approximately 33 miles). It staffs 36 personnel: five registered nurses, three licensed practical nurses or licensed vocational nurses, and 28 other personnel (Montana Department of Health and Environmental Sciences, 1980). The hospital has 18 licensed beds, maternity care, emergency facilities, x-ray department, and a part-time pharmacy (Montana Department of Health and Environmental Sciences, 1980). During 1980, the hospital had a 20.9 percent occupancy rate (patient days/ licensed beds x 365 days x 100%). Over 60 percent of respondents considered hospital service to be of poor to fair quality.

Forsyth is also the closest city offering nursing home facilities to Colstrip residents. The Rosebud Community Nursing Home has 39 skilled-care beds and eight intermediate-care beds, and experienced an 82.9 percent occupancy rate in 1980 (patient days/(skilled beds + intermediate beds)/days reporting x 100%) (Montana Department of Health and Environmental Sciences, 1980). Most respondents (75 percent) had no opinion of nursing home care or stated that it was not available.

h. Housing

Total housing units in Rosebud County increased from 2,055 in 1970 to 4,363 in 1980, or 112.3 percent. Of the 1980 count, it is estimated that 3,764 were occupied households (see Table 13, Appendix I). This is based on the assumption that the 576 housing units counted in Colstrip that were in addition to the 1980 census count were occupied. Mobile homes accounted for almost 60 percent of all new housing units in Rosebud County between 1970 and 1980, due to the reliance of energy growth areas on this type of housing (U.S. Bureau of the Census, 1981). About 42 percent of the county's housing unit increase occurred in Colstrip (Mountain West Research, Inc., 1981). The rapid growth in mobile homes in the county is reflected in the differences between Rosebud County and the state in 1980 housing mix. Whereas the share of total housing units that are multi-family is similar, mobile homes comprise 36 percent of the county's housing stock, and only 12 percent of the state housing stock.

Baseline projections of housing demand (households) in Rosebud County through 2020 are presented in Table 13, Appenddix I. These estimates of average household size for permanent and temporary population applied to the population projections given above yield a peak projected

baseline housing demand of 5,624 units in 1982, 1,860 more than the 1980 figure. Households are then projected to decline by 1,672 by 1985, remain stable through 1990, and increase by 820 from 1990 to 2010 (Western Analysis, 1982).

Prior to 1968, the townsite of Colstrip was owned by the Northern Pacific Railroad, and consisted of about 63 houses. In 1968, the Montana Power Company (MPC) bought the community, and has controlled the pace and scope of commercial and residential development since. Through its subsidiary, the Sunlight Development Company, MPC has (since 1970) financed and/or constructed single-family dwellings, multi-unit apartments, mobile home spaces and recreational vehicle (RV) pads, and temporary housing for the construction work force associated with Colstrip Units 1 through 4, and Western Energy mining operations (Colstrip High School Bond Prospectus, 1981).

Between 1970 and 1980, Western Energy and MPC developed about 960 housing unit in Colstrip. It has been estimated that in 1980, 1,050 units were avilable in Colstrip (Mountain West Research, Inc., 1981). Of the total, 250 were single-family homes, 292 were multi-unit dwellings, and 508 were mobile homes (Reardon, 1982).

In January 1982, the Sunlight Development Company reported that 1,403 permanent housing units and 906 temporary units are available, and 405 more units are under construction. In addition, 124 additional single-family units are proposed, and 224 additional lots are available for development (Reardon, 1982).

Costs of housing are higher in Colstrip than Forsyth. Homes that cost $80,000 to $85,000 in Colstrip are priced at $50,000 to $60,000 in Forsyth. Apartment rentals in Colstrip are $155 per month for a one bedroom, $205 to $350 per month for a two bedroom, and $255 to $450 per month for a three-bedroom unit. Houses rent for over $500 per month. Installed mobile homes rent for $280 to $370 per month (Mountain West Research, Inc. 1981; Reardon, 1982).

There are few vacancies in Colstrip today. Roughly twelve unsold homes are being held for permanent operator personnel at Colstrip Units 3 and 4. Few, if any, houses are available for rent. Some trailer and RV spaces are available. The bachelor camp is at 96 percent of capacity (Reardon, 1982).

Current plans are to convert the Big Timber, Sweet Grass, and Stillwater mobile home pads to single-family lots after the construction phase for Colstrip Units 3 and 4. This would make available 550 more lots, in addition to the 224 potential lots mentioned above. The temporary construction work force housing will be maintained after the construction phase to house the yearly maintenance crews (Reardon, 1982).

Baseline projections of housing demand in Colstrip are contained in Table 13, Appendix I. Housing demand is expected to peak in the fourth quarter of 1982 at 2,731 units, decline 62 percent to 1,042 units in

1985, and gradually increase to 1,171 units in 2010. The projected baseline peak housing demand is 152 units fewer than the existing units, plus those under construction and proposed (Western Analysis, 1982).

i. Education

Colstrip School District #19 currently operates two elementary schools and a junior-senior high school complex. The Isabelle Bills Elementary School is a masonry structure completed in 1978. It includes a large library and gymnasium, in addition to classroom and office space. In mid-January, 1982, the enrollment was 370 students. Instruction is offered from kindergarten to sixth grade. Class sizes range from 17 to 28 pupils and the average class size is 20.6. Children attending the Isabelle Bills School live predominantly in the original section of the Colstrip townsite and Castle Rock neighborhoods (Tokerud, 1982).

The Big Timber, Sweet Grass, and Stillwater mobile home neighborhoods, located north of the original Colstrip townsite, are served by the Pine Butte Elementary School, a modular, wood-frame building. It is intended to be a temporary facility until a new Pine Butte School (under construction) is ready for student occupancy in the fall of 1982. The mid-January, 1982 enrollment at Pine Butte School was 340 students, in kindergarten through sixth grades. Class sizes range from 14 to 21 students, with an average class size of 17. (Tokerud, 1982).

Both elementary schools have large physical plants and have space for many more students. Accreditation standards for class size established by the State Board of Education are the principal limitation to increased school enrollments. Current minimum accreditation standards limit elementary classes to a maximum of 24 students in kindergarten, 26 students in the first and second grades, 28 students in the third and fourth grades, and 30 students in grades five through eight (Montana Board of Public Education, 1976). At present, two kindergarten sessions in the Isabelle Bills School, each with 28 students, exceed accreditation standards. All other classes are well below the accreditation standards. Using the minimum accreditation standard as a guide, the existing elementary school classroom configuration could accommodate up to 321 students. There are 119 available vacant student spaces in the Isabelle Bills facility and 202 available spaces in the Pine Butte School. In mid-January, 1982, the Colstrip elementary school district was being operated at approximately 69 percent of capacity (Hofeldt, 1982).

Colstrip Junior High School is located behind the high school in a modular, wood-frame structure that was erected in the early 1970s to accommodate increased school enrollments associated with the construction of Colstrip Units 1 and 2. The building will need to be replaced in the near future. The seventh- and eighth-grade enrollment is 158 children and the average class size is 21.1 students, well below the accreditation maximum class size of 30 students (Tokerud, 1982).

Colstrip High School is a masonry structure. It was erected in 1944 and remodeled in 1966 and 1978. A modular wood-frame structure was recently added to the north side of the high school for temporary use

until the proposed new high school is completed. The new high school building will occupy 136,000 square feet of space and accommodate 500 students. It will include space for the basic educational program, vocational education, a 600-seat auditorium, 2,000-seat gymnasium, indoor swimming pool, and central food facility for the entire school district. The new high school will cost $13,074,250, of which $3,367,833 is being paid for by a grant from the Montana Coal Board. When the new high school is completed in the fall of 1983, the current high school structure will be converted to a middle school for grades six through eight (Schye, 1982).

Secondary school accreditation standards limit class sizes to 30 students except in instrumental and choral music, physical education, and typing, where classes can be larger. In addition, individual teacher/student loads are limited to a maximum of 160 students except in the areas noted above (Montana Board of Education, 1976). In mid-January, 1982, the Colstrip High School enrollment was 323 students. Class sizes ranged from one to 23 pupils, with an average class size of 9.1 students (excluding study hall). The largest individual teaching load for an instructor was 77 students. Given the size of its current physical plant and student/teacher ratio, the Colstrip High School enrollment could practically double before significant expenditures for instructional staff or facilitites would be necessary (Hofeldt, 1982).

Colstrip School District #19 currently employs 170 persons, including 12 administrators, 106 professional staff, and 52 support personnel (e.g., secretaries, custodians, cooks, etc.) (Montana Board of Education, 1976).

6. Public Finance

The following analysis of public finances in Rosebud County includes the three taxing jurisdictions of Rosebud County, High School District #19 (Colstrip), and Elementary School District #19 (Colstrip). It also includes the townsite of Colstrip, which is owned by Montana Power Company and managed by the Sunlight Development Company. The historical analysis includes an examination of historical revenues, expenditures, taxable valuation, and mill rates. The historical analysis was used in conjunction with information provided by informed officials familiar with the study area in making the baseline projections to the year 2018. The projections were developed using PUFMOD, a local government public finance simulation model developed by Western Analysis, Inc. (see Technical Support Document).

For the purpose of analysis and projections, all dollar figures have been converted to constant 1980 dollars using the GNP implicit price deflator.

a. Historical Conditions

During the period 1970 to 1980, real per capita taxable valuation increased 8.31 percent annually in Rosebud County due to industrial and

coal development in the area around Colstrip. Similar increases were experienced by the two school districts in Colstrip. In comparison, real per capita taxable valuation declined or increased at a much lower rate in comparable jurisdictions. Since 1975, the addition of generating Units 1 and 2 has increased Rosebud County taxable valuation about 30 percent. The additions of Units 3 and 4 are projected to increase the county's taxable value another 15 percent by 1986. Units 3 and 4 will thereafter decline in terms of relative importance as the property depreciates.

For Rosebud County and both Colstrip school districts, total operating expenditures and total expenditures increased significantly between 1970 and 1980 (Table 14, Appendix I). On a real per capita basis, the average annual rate of increase was 8.19 percent for total expenditures and 5.61 percent for total operating expenditures. Because of the sizable enrollment increases in the Colstrip schools, ranging from 150 percent to 444 percent during the period from 1970 to 1980, real total school expenditures per average number belonging (ANB) increased at most by 0.15 percent annually. Despite the real increases in virtually all major expenditure categories, mill levies in these three taxing jurisdictions decreased at an annual rate of between 5.43 percent and 6.72 percent. These declining mill rates reflect the increase in taxable valuation during this time period due to coal and industrial development.

Revenues experienced similar increases during this same time period. At the county level, total revenues increased 8.19 percent annually in real per capita terms. However, local revenues increased only 4.42 percent annually. The lower rate of increase in local revenues occurred in large part due to the change in the proportion of intergovernmental transfers as a revenue source. In 1970, intergovernmental revenues represented five percent of total revenues for the county; by 1980 they represented 34 percent of total revenues. This change in the revenue mix was consistent with comparable jurisdictions. A similar change was experienced by all governing units in the county due to the influx of Coal Board Grants received to mitigate the impacts of coal development. Of the $32 million of Coal Board Grants issued since 1977, approximately 51 percent of this money has gone to governing units in Rosebud County.

The historical public finance analysis for the Colstrip townsite covered the period from 1977 to 1980. Changes in accounting procedures precluded the inclusion of prior years in the analysis. However, the 1977 to 1980 period included much of the permanent population settlement and infrastructural development associated with the industrial and coal mining development in the area. The townsite has experienced a sizable increase of 30.30 percent annually in total real operating expenditures per capita, while locally generated revenues per capita have increased 22.57 percent annually, in real terms. The relatively higher rate of increase in per capita expenditures vis a vis revenues can be explained by the residential, infrastructural, and community service development that has occurred in order to establish and serve the growing permanent population in the townsite. Despite the differences in rates of increase between revenues and expenditures, the townsite operation has remained economically viable for Sunlight Development Company, based on available information (Reardon, 1982).

b. Baseline Fiscal Projections

Baseline fiscal projections for Rosebud County, the two Colstrip school districts, and the Colstrip townsite were estimated to the year 2018. Balanced budget scenarios were developed using PUFMOD for the three taxing jurisdictions. The Colstrip townsite projections were developed using per capita rates of change for each of the revenue and expenditure categories in the simulation model.

The balanced budget approach used in these projections provides an indication of what property taxes must be in order to balance the budget, given a predetermined level of expenditures and nontax sources of revenues. Using estimates of the expected taxable valuation and given the corresponding year's property taxes, the mill levies needed to generate that level of property taxes can be determined. Tables 15 through 17, Appendix I, contain the projections for Rosebud County, Colstrip High School District #19, and Colstrip Elementary School District #19.

The initial annual increases in real operating expenses per capita in Rosebud County result from the continuance of historical annual increases in general government and public safety expenses of 4.46 percent and 16 percent, respectively, through fiscal year 1983, when the population peaks. Thereafter, public safety expenditures increase at a declining rate until 1987 when the population stabilizes. Public services and transportation expenditures are assumed to continue their historic real per capita annual rates of increase of 1.17 percent and five percent, respectively, through 1986. These forecast percentage increases permit the continued development of these county services during this period of population growth. Thereafter, all operating expenditures are held constant in real per capita terms.

Infrastructural development is assumed to be near completion with regard to the county government, therefore capital outlays are assumed to be cut in fiscal year 1982 to their historic per capita level. Since Coal Board Grant funds for impact mitigation are expected to fall off dramatically, as are federal transfer payments, intergovernmental revenues are reduced by over 50 percent, bringing them back to prior years' per capita levels.

Based on these assumptions for Rosebud County, the estimates contained in Table 15, Appendix I show an increase of 25 percent to 47 percent in the major expenditure and revenue categories through fiscal year 1983. Thereafter, throughout the forecast period, there are moderate fluctuations in real terms reflecting changes in population. Between 1982 and 1990, mill levies decrease approximately 48 percent and thereafter rise by 2.17 percent annually. The later mill levy increase is due to projected declines in taxable value caused by decreasing coal production and the declining real values of industrial plant and equipment.

Operating expenditures per capita are held constant at 1981 levels in both the high school district and the elementary district, with one

exception. Elementary instruction expenditures are assumed to increase 6.50 percent through 1984, bringing per capita instructional expenditures back up to the 1980 peak of $2,171 per ANB. Since the additional teachers are expected to be only temporary, after 1984 instruction expenditures are assumed to return to historic levels.

The baseline projections for the high school district include the sale of $9.7 million in bonds, with debt service payments beginning in 1983 and extending through 2002.

Nonproperty tax school revenues are held constant in real per capita terms, with two exceptions: 1) county funds to the elementary district continue their historic 3.66 percent annual increase to supplement the funding for the additional temporary teachers; 2) per ANB federal funds to the high school decline 11.50 percent due to recent federal funding policies.

Tables 16 and 17, (Appendix I), contain details of the baseline forecasts based on these assumptions. As expected, revenues and expenditures are forecast to peak in 1983 and will thereafter exhibit moderate, generally downward-trending fluctuations.

Mill levies in these two balanced budget scenarios are more erratic than those forecast for the county due to the relatively greater influence of coal production and prices on the taxable valuation of the school districts.

Colstrip townsite baseline projections presented in Table II-18, Appendix I, include three major capital outlays as part of the baseline assumptions. All three projects are expected to be funded solely by Coal Board Grants. They include: 1) $1.1 million water treatment plant in 1981; 2) $150,000 for a new fire truck and storage facility in 1982; and 3) $300,000 for a snow blower and street cleaner in 1983 (Workman, 1982). No additional capital outlays are included in the baseline projections.

Operating expenditures are assumed to remain constant in real per capita terms with the exception of general expenditures, public services, public utilities, and housing expenditures. These four expenditures are assumed to increase in real per capita terms at their historic annual rates through 1984 (i.e., general expenditures, 3.05 percent; public services, 8.01 percent; public utilities, 14.29 percent; and housing, 16.19 percent). This will enable the continued development of townsite infrastructure and services for as long as the population continues to grow. The growth in residential and community services is assumed to be necessary to attract and maintain a permanent work force.

Real per capita revenues from housing rents and trailer park rents are forecast to decline after 1984, when the population peaks. Housing unit sales are projected to increase at a declining rate until 1987, when the population stabilizes (McIntosh, 1982).

Given the above assumptions, the Colstrip townsite managers can expect a 40 percent increase in real operating expenditures per capita by 1984, with no change thereafter. Real annual total expenditures and operating expenditures are forecast to peak in 1983 when the annual population peaks. Thereafter, expenditures, like revenues, fluctuate moderately with a downward trend through the remainder of the forecast period.

J. LAND USE

1. Present Land Use

The land use pattern and productivity of the 2,693 acres in Area C, Block I are similar to the rest of the Western Energy leasehold at the Rosebud Mine. Approximately 1,904 acres (71 percent) of Area C, Block I is rangeland, with 436 acres (16 percent) cultivated for wheat and 334 acres (12 percent) in hayfield production. The remaining acreage (1 percent) includes sandstone outcrops, clinker (locally known as scoria) pits, and a ranch yard. By comparison, rangeland uses make up about 67 percent of the Western Energy leasehold, 78 percent of Rosebud County, and 74 percent of the 45 million-acre Yellowstone River subbasin (Rosebud County Planning Board, 1979).

Coal development in Rosebud County has temporarily displaced about 3,350 acres of rangeland and 200 acres of cropland (Montana Department of State Lands, 1981). About 77 percent of the disturbance is due to the Rosebud Mine (Table II-13). Additionally, about 550 acres of land at Colstrip and Forsyth have been permanently converted to urban and industrial uses (Montana Department of State Lands, 1981). The cumulative impact of coal mining to date represents about 0.1 percent of rangeland in Rosebud County and about 0.2 percent of Rosebud County's cropland.

The cropland in Area C, Block I represents less than 0.6 percent of the 130,000 acres of cropland in Rosebud County. Principal crops are dryland winter wheat and alfalfa. Average production in Area C, Block I is about 30 bushels per acre for wheat and about 1.2 tons per acre for hay, while average production for Rosebud County is 29 bushels per acre for winter wheat and 1.5 to 2.0 tons per acre for dryland alfalfa (Prinkki, 1982). Production comparisons are presented in Table II-14 and field locations are shown on Figure II-21. Relic irrigation structures occur along Stocker Creek and operational irrigation structures occur along East Fork Armells Creek, but cropland within Area C, Block I is presently farmed on a dryland basis. This cropland is designated as class three and four lands under the Soil Conservation Service Land Use Classification System. Although this classification is considered marginal for crop production as compared to the United States as a whole, it is the best classification of croplands possible, given the regional constraints of low rainfall and a short growing season.

The rangeland in Block I represents less than 0.07 percent of the 2.5 million acres of rangeland in Rosebud County. Presently, rangeland productivity in Area C, Block I is about 0.15 AUMs per acre for grassland and shrubland, based on the Montana Soil Conservation Service Technical Guide (1979) for rangeland in "fair" condition, and about 0.2 AUMs per acre for ponderosa pine areas. Under optimum management, this could be increased to about 0.45 AUMs per acre for grassland and shrubland, and to about 0.23 for ponderosa pine (Appendix G, Table I). The average production level for southeastern Montana ranges from 0.25 to 0.30 AUMs per acre (Montana Department of State Lands, 1981).

TABLE II-13

SUMMARY OF LAND USE IMPACTS OF THE
ROSEBUD MINE

Land Use Category	Pre-mining Use	Present Use[a]
Rangeland		
Grassland and Shrubland	16,500	14,683
Ponderosa Pine	7,440	7,290
Cropland	1,420	1,220
Mining Disturbance	640[b]	315
Mine Facilities and Associated Disturbance	0	424
Reclamation	0	2,011
Bond Release	0	57[c]
	26,000 acres	26,000 acres

[a] Estimated as of 1981 (Montana Department of State Lands, 1981).

[b] Unreclaimed spoils remaining from the original Northern Pacific Mine, and Burlington Northern railroad right-of-way spoils.

[c] County road

TABLE II-14

FIELD PRODUCTION IN AREA C, BLOCK I

Field[a]	Crop	Acres	Production[b]	Acres to be Disturbed
1	wheat/speltz	122	27 bu/ac	90
2	winter wheat	185	33 bu/ac	185
3	winter wheat	34	33 bu/ac	34
4	winter wheat	19	33 bu/ac	19
5	winter wheat	3	33 bu/ac	3
6	winter wheat	28	33 bu/ac	28
7	winter wheat	17	33 bu/ac	17
8	winter wheat	28	35 bu/ac	--
9	crested wheatgrass/alfalfa	13	1.0 t/ac	--
10	crested wheatgrass/alfalfa	50	1.0 t/ac	12
11	crested wheatgrass/alfalfa	43	1.0 t/ac	20
12	crested wheatgrass/alfalfa	91	0.6 t/ac	91
13	crested wheatgrass/alfalfa	70	1.5 t/ac	70
14	crested wheatgrass/alfalfa	36	1.5 t/ac	36
15	crested wheatgrass/alfalfa	11	0.6 t/ac	--
16	crested wheatgrass/alfalfa	20	0.6 t/ac	1
		770		606

a Field locations are depicted in Figure II-21

b Based on land owner interviews conducted in September, 1980 and 1981 as reported in Western Energy Company's Application for a Surface Mining Permit Area C, Block I. Production figures reported by Burlington Northern (Western Energy Company, 1981) are somewhat lower.

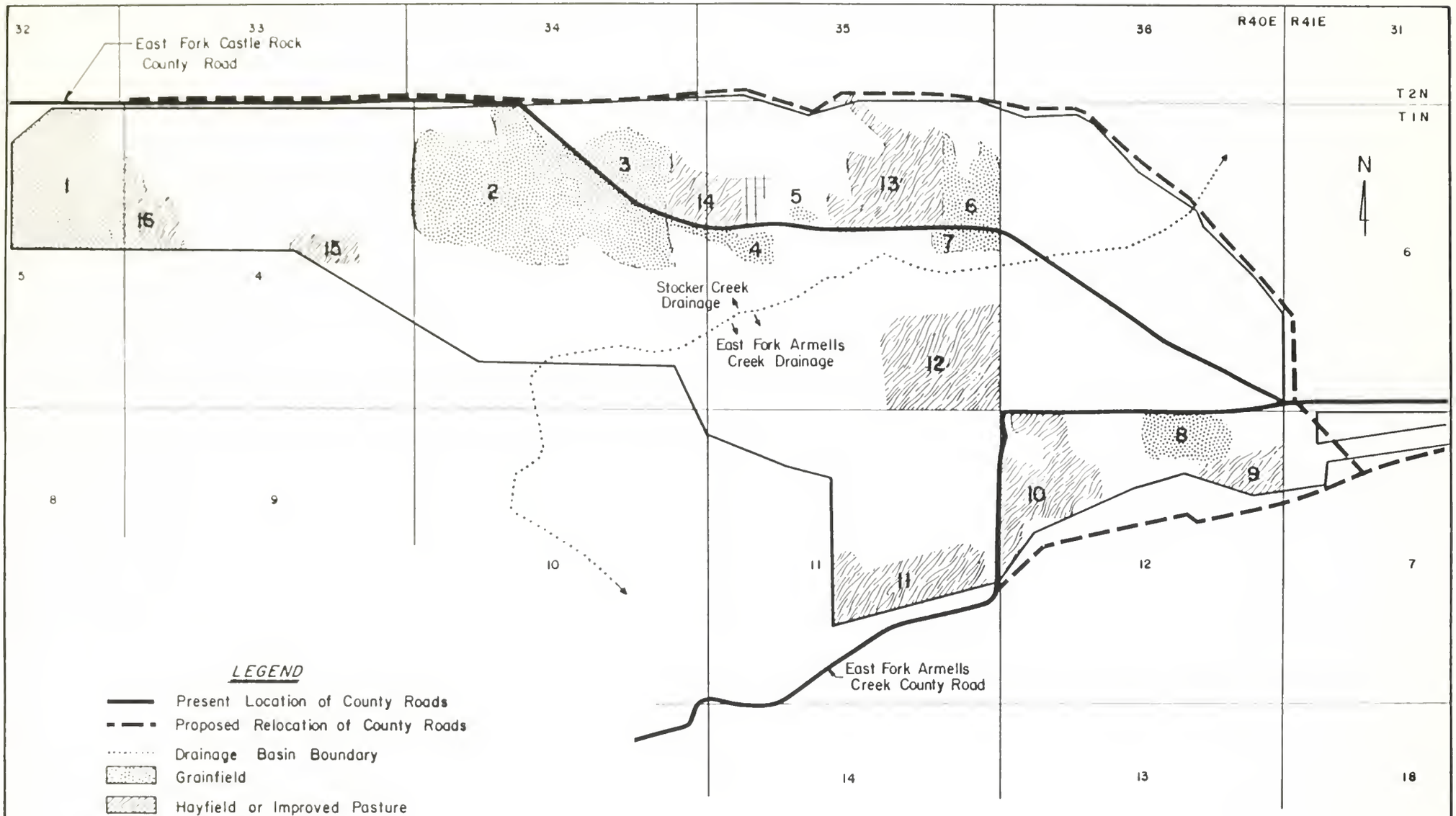


FIGURE II-21 AGRICULTURAL USE IN AREA C, BLOCK 1

2. Federal Planning

Portions of the coal in the Rosebud Mine are federally owned and administered by the Bureau of Land Management. The BLM has developed a land use plan called the Management Framework Plan for the South Rosebud Planning Unit. The mining plan described in the mine permit application for Area C, Block I is compatible with the recommendations made in the Management Framework Plan.

3. Local Land Use Planning

The future land use plan for Colstrip is contained in the Rosebud County Planning Data Book and Comprehensive Plan (1979). Since Colstrip is a privately owned company town, it is not subject to city council-adopted regulations or zoning plans. The future land use plan for Colstrip as designed for Montana Power Company has been approved by the Rosebud County Planning Board.

K. TRANSPORTATION

Rosebud County's transportation network consists of a series of roadways, two railroads, five commercial truck lines, a bus line, and a county-owned and operated airport located in Forsyth. Road travel is the most common mode of transportation in Rosebud County. Graveled county roads and two-lane state highways service the Colstrip area (Figure II-22). Federal Aid Primary (FAP) 39 connects Colstrip with Interstate 94, the major east-west highway to the north, and with FAP 37 (US 212), a heavily used east-west highway to the south. Access to Area C, Block I is along FAP 39, located about three miles east of the area, and by Castle Rock County Road running adjacent to the area.

The Montana Department of Highways is in the process of reconstructing 31 miles of FAP 39 in order to meet the increased traffic demand resulting from coal development in the area. A seven-mile section south of the intersection with I-94, and a 5.8-mile section at Colstrip have already been completed, with the entire project scheduled to be completed in spring, 1983 (Randall, 1982). The reconstruction consists of widening the roadway, resurfacing, realignment where needed, and providing grade separations at the four places where FAP 39 and the Colstrip railroad spur intersect. The theoretical capacity of the reconstructed highway is estimated to be 200 vehicles per hour (Colbert, 1982). These reconstruction projects are financed in part by coal severance tax augmented with Federal Aid Primary Funds.

FAP 37, which intersects FAP 39 at Lame Deer, leads west to Busby, Crow Agency, and Hardin, and east to Broadus in Powder River County. This road is heavily used by trucks and the Department of Highways is currently planning to reconstruct 27 miles of FAP 37 between Crow Agency and Busby, although there is no scheduled completion date at this time.

Traffic on the major highways leading to Colstrip has increased considerably since coal development at Colstrip (Table II-15). Traffic on FAP 37 increased about 77 percent from 1968 to 1980. Traffic on FAP 39 from Colstrip to I-94 increased about 562 percent from 1968 to 1981. The majority of the increase in traffic levels is due to power plant construction with about 20 percent of the increase contributed by mining activity. This increased traffic and the deteriorating road conditions made FAP 39 extremely unsafe (rated 1 on a scale of 20 by the Montana Department of Highways), but the scheduled reconstruction projects should alleviate many of the dangers involved in driving this highway.

A railroad spur connects Colstrip and the Burlington Northern mainline about 25 miles to the north of Colstrip (Figure II-22). This spur serves both Western Energy's Rosebud Mine and Peabody's Big Sky Mine, 7.5 miles south of Colstrip. Coal from the Rosebud Mine is shipped to such places as Billings, Montana; St. Paul, Minnesota; and Bayfront, Wisconsin. On certain occasions, the Colstrip spur is also used to haul heavy machinery for construction projects. An average of three loaded unit trains per day used the Colstrip spur in September, 1981 for a total of six trips per day, counting returning empty trains (Coefield, 1982).

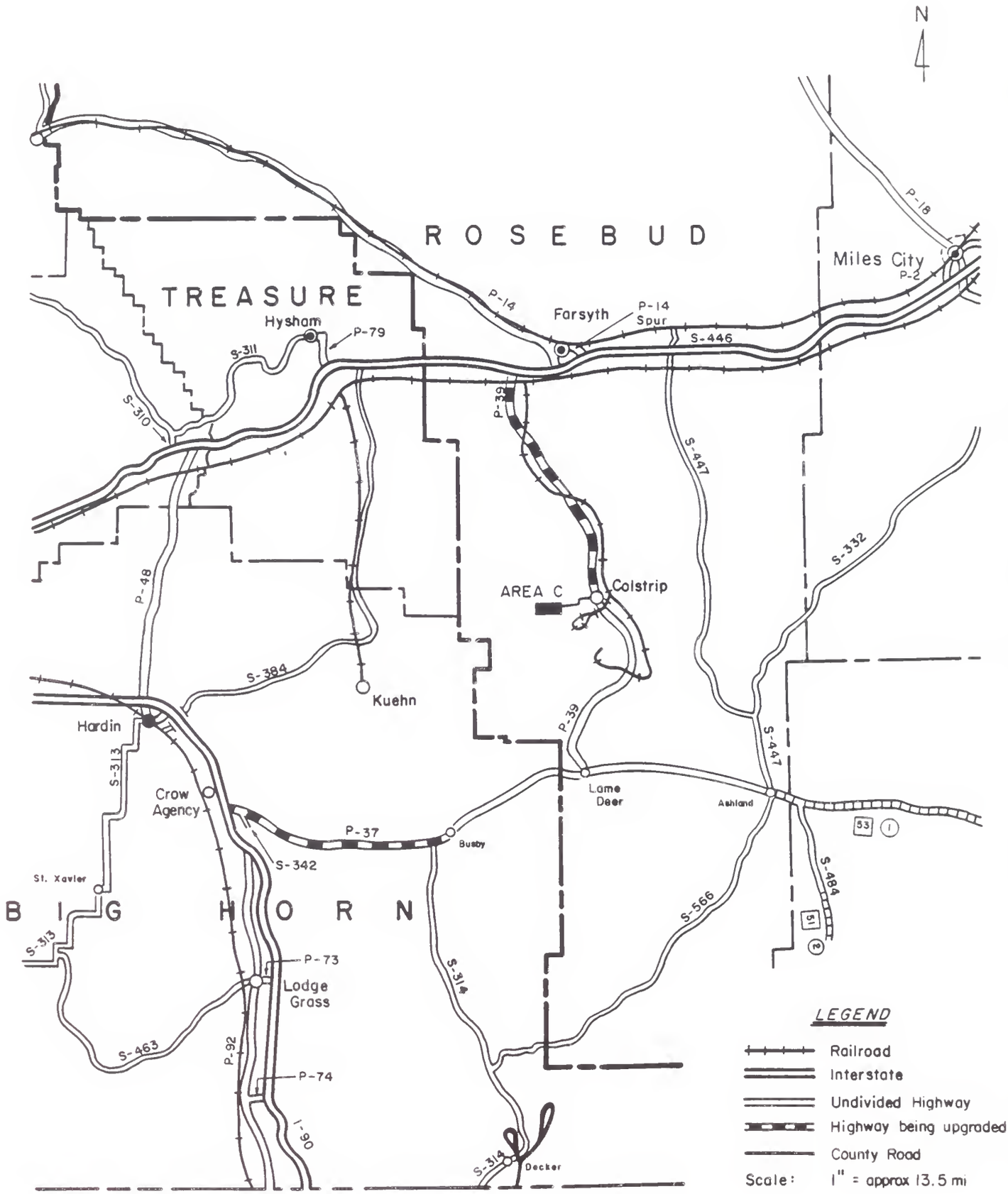


FIGURE II-22 TRANSPORTATION ROUTES NEAR COLSTRIP

TABLE II-15

AVERAGE DAILY TRAFFIC COUNTS FOR HIGHWAYS NEAR COLSTRIP, 1968-1981

Highway Segment	Year													
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
FAP 37														
Jct. 342 to Busby.....	673	603	657	701	766	860	778	791	1,052	1,443	1,159	1,130	1,250	---[1]
Busby to Rosebud County line.....	782	773	802	766	854	924	914	1,072	1,223	1,585	1,153	1,130	1,250	---[1]
Rosebud County line to Lame Deer.....	858	850	863	820	962	1,033	1,011	1,263	1,243	1,800	1,370	1,130	1,590	---[1]
FAP 39														
Lame Deer to Reservation boundary.....	238	274	320	363	395	---	---	---	359	511	585	640	1,180	---[1]
Reservation boundary to Colstrip.....	159	170	195	203	269	508	451	498	388	344	364	340	610	---[1]
Colstrip to I-94 interchange.....	210	190	236	253	370	1,193	1,047	1,425	1,087	783	678	570	1,270	1,390[2]

1 Data for 1981 not yet compiled

2 ADT from permanent counter located 6 miles south of the Colstrip Interchange

[Source: Montana Department of State Lands, 1981; Bill Colbert, Montana Department of Highways, 1982]

L. RECREATION

1. Urban Recreation Resources

Most formal recreational activities in Colstrip are provided by the Colstrip Area Recreation and Parks Association (CARPA), a citizen organization concerned with recreation in Colstrip. The organization is supported by contributions from the energy corporations located in Colstrip (about 90 percent of the total capital and operation budget) and fees from association memberships. At present, CARPA numbers 287 family, adult, and youth memberships (Noyd, 1982). Resources available under the aegis of CARPA include a 51-acre park system, a swimming pool, a wading pool, three tennis courts, three basketball courts, and five playgrounds for young children. Indoor facilities are provided at the Colstrip Community Center and comprise 16,000 square feet of space allocated to two handball/racquetball courts, a weight/exercise room, a basketball court, and a meeting room (Colstrip High School Bond Prospectus, 1981). Other indoor facilitites include a library and a former construction dining hall, which has been converted and is currently used for meetings and other social gatherings (CARPA Recreation Guide, 1980). Colstrip is in the process of creating a new outdoor recreation complex, to be named Stillwater Park, which will comprise two softball and one baseball fields, a soccer field, an outdoor basketball court, and a playground area (Mountain West Research, Inc., 1980).

Nearly 60 percent of surveyed residents considered the adequacy of organized recreation in Colstrip to be good to excellent. Over 51 percent considered Colstrip area recreational opportunities to be adequate to great; about 45 percent considered them to be limited or insufficient. Popular organized recreational activities of surveyed residents include baseball/softball (40 percent), movies/dining (83 percent), dancing (55 percent), and bowling (46 percent). Facilities for these activities are limited in Colstrip except for baseball/softball fields.

2. Nonurban Recreation Resources

Developed, public recreation resources in the area are limited. Four federal, four state, and one private nonurban recreation site have been developed within the county. Table II-16 summarizes facilities and activities available at the sites.

The U.S. Forest Service manages 95,827 acres of forest land for recreational purposes within the county and maintains 217 road miles of access within that area (Montana Department of Fish and Game, 1978). In addition, some 230,000 acres of public land managed by the Bureau of Land Management are available to public use. A motocross course, rodeo grounds, and the Rosebud Park are available in the Forsyth vicinity (Montana Department of State Lands, 1981).

The Tongue River Reservoir, located in Bighorn County, about 55 miles south of Colstrip, is the only major water impoundment in Rosebud

TABLE II-16

NONURBAN DEVELOPED RECREATION SITE INVENTORY - ROSEBUD COUNTY

DESCRIPTION	FACILITIES/ACTIVITIES			
Name	Picnic Units	Camp Units	Other*	Fee
FEDERAL OWNERSHIP				
1. Poker Jim Butte	3	0		$0
2. Crazy Head Springs	3	5	S, F	0
3. Green Leaf	0	0	F	0
4. Lost Leg	0	0	F	0
STATE OWNERSHIP				
1. East Rosebud	5	0	F, FT	0
2. Far West	0	0	F, FT	0
3. West Rosebud	0	10	F, FT, BA	0
4. Forsyth Rest Area	5	0	I, W	0
PRIVATE AND NONPROFIT				
1. Wagon Wheel	0	20	TC, W, F	3

*KEY: Facilities/Activities - Other

F - Fishing
I - Information or interpretive exhibits
S - Swimming area
TC - Trailer/camper hookups
W - Waste disposal station
BA - Boat access
FT - Float trips

Abstracted from 1978 Montana Statewide Comprehensive Outdoor Recreation Plan (SCORP), Volume 2, Outdoor Recreation Inventory

County. The reservoir is largely undeveloped for recreation, although three primitive camping areas exist nearby. The reservoir fishery offers a number of warm-water game species. The Tongue River below the reservoir also offers recreational resources and opportunities and sustains a trout fishery in its upper reaches and a warm-water fishery in the area downstream of Birney. Access to the river upstream of Ashland, however, is limited by private owners and the Northern Cheyenne Indian Reservation. The Yellowstone River also is available for boating, fishing, and other recreational activities; two fishing access sites and two recreation areas are located on the river near Forsyth (Mountain West Research, 1980). Montana Power Company allows access to Castle Rock Lake, the 152-acre surge pond that provides make-up water for the Colstrip generating units and the Colstrip public water supply (Williams, 1982).

The results of recreation surveys conducted in 1976 and 1977 by state authorities indicated that area residents prefer recreation in undeveloped, natural areas. A survey conducted by Western Analysis (1982) confirms these findings. Over 75 percent of surveyed adults camp, picnic, hunt, or fish. Sixty-seven percent enjoy swimming. Outdoor recreation in the Colstrip area reportedly is not now approaching the capacity of the area's recreational resources (Montana Department of State Lands, 1981). Still, federal authorities anticipate increased demands for recreation, particularly motorized recreation, picknicking, overnight camping, and fishing. Federal land resources are to be managed to satisfy such demands (Mountain West Research, 1980).

M. CULTURAL RESOURCES

Several cultural resources surveys have been conducted since 1971 that include some or all of the lands within Area C, Block 1 (the direct impact area) and surrounding one-mile buffer zone (the indirect impact area). DSL requires a buffer zone to preserve, to the extent possible, important cultural resources from the effects of blasting. The seismic effects of blasting can affect rock art, rock shelters, and historic sites with standing structures. Table 1, Appendix M summarizes this survey information. A summary of cultural resources found and their National Register eligibility follows.

1. Area C, Block 1

Nine cultural resources sites were recorded during surveys within Area C, Block 1. Five of these are prehistoric, one is historic, and three are of unknown affiliation. These sites are summarized below and in Table 2, Appendix M.

a. Prehistoric Sites

- The Cooley Site (24 RB 1059). This site was first recorded in 1973 (Fredlund and Fredlund, 1974) and re-evaluated in 1980 (Fredlund, 1980) and 1981 (Steere, 1982). The applicant's archaeological consultant (Mineral Research Center) reports the site to be a prehistoric temporary campsite. It consists of a lithic scatter located next to a spring and evidences subsurface cultural deposits (Steere, 1982). The 1981 reevaluation and testing indicate the site is much larger than initially thought (Steere, 1982).

- The Medicine Root Site (24 RB 879). This site was recorded in 1981 as a prehistoric occupation site. It consists of a large lithic scatter, and initial testing revealed the presence of subsurface cultural deposits (Mineral Research Center, 1982).

- The Fadhl Kill Site (24 RB 299). This site was first recorded in 1973 (Fredlund and Fredlund, 1974) and was reevaluated in 1981 (Steere, 1982). The site is recorded as a prehistoric bison impoundment, kill, and processing site. The consultant feels it may also represent an occupation site. All test pits revealed subsurface cultural deposits (Mineral Research Center, 1982).

- The Tripoint Site (24 RB 873). This site was first recorded in 1981 as a prehistoric hunting lookout, lithic workshop, and temporary occupation site. Testing revealed no subsurface cultural deposits (Mineral Research Center, 1982).

- The Farley Lookout Site (24 RB 1058). This site was first recorded in 1973 (Fredlund and Fredlund, 1974), reevaluated in 1980 (Fredlund, 1980), and tested in 1981 (Steere, 1982). The site was recorded as a hunting lookout and temporary campsite. Testing in 1981 revealed subsurface cultural deposits (Steere, 1982; Mineral Research Center, 1982).

b. Historic Sites

- Fadhl Homestead (24 RB 884). This historic homestead complex, still in use today, was first recorded in 1981 (Mineral Research Center, 1982) and is thought to be underlain by portions of the prehistoric Fadhl Kill Site (Steere, 1982). The complex includes thirteen standing wood frame buildings that date back to the 1920s when the site was first homesteaded. Numerous historic documents on the homestead allow compilation of a detailed ownership history (Mineral Research Center, 1982; Steere, 1982).

c. Sites of Unknown Affiliation

- The Three Ring Site (24 RB 1060). This site was first recorded in 1973 (Fredlund and Fredlund, 1974) and reevaluated in 1980 (Fredlund, 1980). The site consists of three stone circles of unknown cultural or temporal affiliation. The rings may be prehistoric tent rings or may be associated with the nearby Cooley Place Homestead. No artifacts were found in association with the stone rings (Fredlund and Fredlund, 1974; Fredlund, 1980).

- The Lynn's Square Site (24 RB 1071). This site was first recorded in 1973 (Fredlund and Fredlund, 1974) and reevaluated in 1980 (Fredlund, 1980). The site consists of a rectangular sandstone rock structure. No cultural material was found associated with the feature or in the test pit. The feature's function and origin are unknown (Fredlund and Fredlund, 1974; Fredlund, 1980).

- Gene's Vision Quest Site (24 RB 1072). This site was first recorded in 1973 (Fredlund and Fredlund, 1974) and reevaluated in 1980 (Fredlund, 1980). The site consists of two rock structures located on the crests of two knolls adjacent to the historic Doc Taylor's Homestead site. The origin and function of these features are unknown. The consultant suggests it could be a prehistoric vision quest site or could be associated with the historic homestead and may possibly be children's forts (Fredlund, 1980).

Based on the information currently available on the nine sites, the Three Ring, Lynn's Square, Tripoint, and Gene's Vision Quest sites appear to be ineligible for nomination to the National Register based on the lack of potential for yielding additional information on the prehistory or history of the area. Although the Medicine Root site has been tested, its extent indicates the need for additional testing in order to evaluate its potential eligibility. The Cooley, Fadhl Kill, Fadhl Homestead, and Farley Lookout sites may be eligible for nomination because of their potential to yield additional information on the history and prehistory of the area.

DSL, the State Historic Preservation Office (SHPO), and the Office of Surface Mining (OSM) had not yet received the final report on the Archaeological Survey of Area C, Block I and buffer zone when this EIS was finalized. These agencies will review the report and assess the potential of the sites for National Register eligibility at the earliest possible date. Determinations of eligibility will be sought from the keeper of the National Register prior to any disturbance.

2. One-Mile Buffer Zone

Twenty-four cultural resources sites and one "Minimal Activity Locus" (MAL) were recorded during surveys within the one-mile buffer zone around Area C, Block 1. A "Minimal Activity Locus" is defined as a location that has a small amount of cultural debris and has the potential to yield limited information to the interpretation of prehistoric or historic cultural activity (Fredlund, 1980). Sixteen of these are prehistoric, six are historic, and three are multi-component sites consisting of both historic and prehistoric components. A brief synopsis of these sites is presented in Table 3, Appendix M.

Of the 24 sites recorded within the buffer zone, only one (How Dry I Am Site) has been determined ineligible for nomination to the National Register (Montana State Historic Preservation Office, 1981). This determination was made as a part of the review of an adjacent area of the Rosebud Mine (Area B). Fifteen other sides (McDonald Quarry, Lovelace Memorial, Petro City, Rabbit Ridge, Rocky Top, Dusty Shelter, Caskey 320, Castle Rock Post Office and Homestead, P.E. Davis Rock Art, Wheatfield Vista, Connie's Gallery, Pottery, Sunburn Out, Pigeon, and Normand Estates sites) appear to Western Energy to be ineligible for the National Register based on their lack of potential to yield useful information and/or their lack of integrity as a site (due to natural deterioration, destruction, alteration, etc.). The Forsite, East Fork, and Albino Deer sites need testing before National Register recommendations can be made. This however, would be necessary only if mining were to expand into these portions of the buffer zone at some future point. It is recommended that testing be done on the minimal activity locus (MAL 1401) to determine whether it warrants a site designation prior to considering a National Register recommendation. The Sly Bison, Insite, Cooley Place, Doc Taylor's Place, and the Muskrat Homestead sites are potentially eligible for the National Register and official determinations of eligibility will be sought.

No Native American concerns as defined under the American Indian Religious Freedom Act of 1978 were identified for Area C, Block I or the buffer zone. However, much of the work conducted in the area was done prior to the law's enactment and no consultations with Native American groups have been made.

N. AESTHETICS

Determination of the aesthetic values of any given place is a subjective process determined by each individual's perceptions, tastes, and values.

Texture, color, relief, and contrast make up most of what we see in a landscape. At the Rosebud Mine, Area C, Block I, the texture varies from the even range grasses on gentle slopes to smooth, linear sandstone outcrops, to the jagged profile of ponderosa pines on the skyline. Colors are mostly neutral: pale yellow, tans, browns, and greys, with dark greens in the timber and scattered orange, rust, and purple clinker outcrops. Relief is low to moderate and slopes are generally broken only by the scattered sandstone or clinker ledges on the upper slopes and ridges. The most striking contrast is between the light range grass covering open slopes and the dark ponderosa pine stands along the higher ridges and divides. In cropland areas, a distinctive contrast exists between the long, straight plow rows (and subsequent linear crop lines) and the free-flowing, gradational contacts between natural vegetative types.

The sounds that currently dominate Area C, Block I, are typically natural and rural, associated with ranching, rangeland farming, and light traffic on the county road. Block I is sufficiently removed from the present mining activity around Colstrip that the sounds of that activity cannot readily be heard.

CHAPTER III

ANALYSIS OF IMPACTS

A. GEOLOGY

1. Topography/Geomorphology

The post-reclamation topography would approximate the existing landscape in Area C. A general smoothing of the topography and a slight reduction in elevation would be the obvious changes, with drainages and divides restored to their approximate pre-mine location. The current Block I plan does leave an undisturbed sandstone ridge in part of the southern permit area. This would be the only undisturbed bedrock in the permit area. A proposed post-mine topographic contour map for Area C, Block I is included in the mine permit application and in the Technical Support Document.

While the topography of Area C would be modified, the landforms would largely be constructed and continue to develop on reclaimed spoils materials. Due to the proposed reclamation techniques (see Section F, Soils), these surficial materials would be highly variable over space and with depth. Consequently, broad landscape units would not develop, but rather a range of land forms would develop on a single anisotropic medium.

The characteristics of the surficial materials anticipated under post-reclamation conditions are summarized in Table III-1. The characteristics of these materials, which determine their erodibility, are in themselves strongly influenced by the techniques employed during reclamation.

Studies of currently reclaimed spoils in the Colstrip area and estimations of source area sediment yields under post-mining conditions (see Technical Support Document for detailed studies), suggest that yields would be moderate in comparison with undisturbed conditions. The highest yields can be anticipated on topsoiled spoils on which only a limited vegetation cover has developed. As vegetation cover (including root density and soil organic content) increases during reclamation, source area sediment yields will decrease.

Other large scale sources of instability in the reclaimed landscape could include accelerated erosion at the highwall interface and subsidence due to settling of the spoils. The long-term significance of these problems are difficult to assess.

There is a potential for increased infiltration along the highwall zone, which could result in piping and the formation of gullies. Differential erosion rates between the competent bedrock and the spoils materials may also occur at the interface, which could result in modification of drainage profiles and base levels, accelerated erosion, and local diversions of drainages. Subsidence and differential settlement may also result in a range of problems.

TABLE III-1

GENERALIZED CHARACTERISTICS OF RECLAIMED LANDSCAPE

Nature of Surficial Materials	Range of Slope Gradient (%)	Vegetative Cover (%)	Drainage Density (Mi/Ml^2)	Infiltration Rate (In/hr.)	Estimated Source Area Sediment Yield ($Acre/Ft/Mi^2$)
Unconsolidated spoils material with sandy loam or loam texture. Bulk densities of 1.3 to 1.8.	Smooth rolling topography <20%. Only limited areas over 10%.	First 3 years after disturbance: 25%. 3-10 yrs. following revegetation: 70% of weeds + grass.	5-8 mi/mi^2	Highly dependent on treatment. 2-4 in/hr.	0.04
Overlain by topsoil. Low organic content (1-2%) and very little armoring.		After 10 years: 75% vegetative cover			

Note: method of calculation discussed in detail in Technical Support Document.

2. Stratigraphy

The portion of the Tongue River Member that constitutes the Rosebud coal overburden would necessarily be disrupted in mining the Rosebud coal seam, and the backfilled material would not have the same stratigraphic characteristics as the undisturbed unit. Inasmuch as the overburden has no unique or intrinsic value, the disruption to this stratigraphic section would not produce a significant impact.

3. Overburden

Mining of the Rosebud coal using conventional dragline overburden removal techniques would nonselectively strip and mix the overburden materials. Studies by Dollhopf et al., (1978, 1979) indicate that "normal spoiling" of overburden results in as good a mixing of the spoiled material as can be reasonably achieved with a large dragline. While large-scale mixing would be achieved, the degree of such mixing is limited by the size of equipment to be employed. Pockets of essentially unmixed and undiluted overburden would be preserved in the reclaimed spoils. Dollhopf et al. (1981) state that materials (exceeding state suspect levels) found in the overburden that make up less than five percent of the overburden in a single test hole are almost never detected in the post-mine spoils. They further found that materials (exceeding state suspect levels) constituting 5 to 15 percent of a hole were generally found in pockets in the spoils, though often diluted. Overburden materials exceeding state suspect levels and constituting greater than 15 percent of the overburden tested were always found exceeding state suspect levels in some sample(s) from the spoils. Table II-2 shows the overburden holes in which suspect materials in the overburden exceed the state suspect levels and what percentage of the samples are in exceedance for each suspect parameter.

Table II-2 suggests that manganese and cadium do not exceed suspect levels in significant volume in Area C, Block 1. The remaining parameters (electrical conductivity, nickel, molybdenum, and sand) all exceed state suspect levels in enough samples to be potentially significant.

An uncertainty exists regarding the drawing of inferences about spoils geochemistry based on the available overburden data. This uncertainty is related to the findings of Dollhopf et al. (1981) in their Western Energy Company Area B study that overburden sampling on a grid pattern with hole density similar to that of Area C (1500- to 2000-foot centers) is only about 50 percent reliable in predicting the occurrence of unsuitable overburden material. (Note: The DSL is currently reviewing its guidelines regarding overburden sampling procedures and sampling density requirements.)

Nevertheless, review of the existing overburden data relative to Western Energy's mining plan suggests that, while stripping and replacing the overburden would result in a material having the same overall bulk chemistry characteristics as the undisturbed materials, several other impacts would likely occur, as follows:

Near-surface electrical conductivity across the mined area would be generally reduced.

- Localized areas of molybdenum, nickel, and sand concentrations above DSL suspect levels may be created in the near-surface spoils.

- Very localized areas where cadmium concentrations may exceed DSL suspect levels in the near-surface spoils may be created.

- Present near-surface materials with high soluble salt contents (electrical conductivity) would be buried in the spoils, thus making the soluble salts available for solution in groundwater.

A discussion of the significance of trace element concentrations, electrical conductivity, and sand content in reclaimed spoils is presented in Chapter III, Sections B and F, and in more detail in the Technical Support Document.

4. Structure and Paleontology

There would be no foreseeable impact on the geologic structure or paleontology of the area as a result of strip mining. However, the structure, particularly the inferred faults in Area C, may have an impact on the recovery of coal in the proposed mine. Mining through a fault having a displacement of 70 feet paralleling the highwall would necessitate a discontinuous pit development in the fault area to get the pit floor down to the coal level. Such a mining procedure would probably leave one or more cuts of coal unmined and irretrievable.

5. Geologic Hazards

No major geologic hazards would result from strip mining, though some instability due to settling in the spoils would occur for a number of years after reclamation. Minor settlement problems have been noted in spoil areas at th existing mine (Hurlburt and Harrington, 1982). These included settlement cracks ranging up to three feet deep in a small area of newly-graded but untopsoiled spoil in Area B, an area of small "sinkhole" features at the toe of a slope in a topsoiled and seeded portion of Area B, and a recent subsidence feature where spoil is settling away from the crest of a backfilled endwall. These problems have occurred within the first three years after regrading. The instability of the backfilled spoils may preclude construction of large structures on the reclaimed spoils until they are stabilized. Normal agricultural use of the reclaimed spoils would probably not be affected.

The proposed limitations on blasting, in terms of weight of explosive per delay charge and associated ground motion in the vicinity of structures, meets the requirements of 10 CFR 715.19. There is some evidence that the proposed limit of one in/sec. peak particle velocity

may allow minor damage in structures, consisting of small plaster cracks or loosening of paint. The limitation on explosive weight would likely generate ground motions that are much lower than the suggested limit, based on analyses of numerous blasts at other surface coal mines. There is no evidence that this shallow blasting would generate tectonic release.

6. Resources

Coal resources would be diminished by the 23.7 million tons of Rosebud coal to be mined in Area C, Block I. In addition, approximately 9.6 million tons of McKay coal in Area C, Block I would probably become an irretrievable resource if not mined when the Rosebud is removed. Any reserves that may be calculated in the Stocker seam would also be irretrievably lost, since it is highly unlikely that either the Stocker or the McKay would ever become more economic to produce than at the time of mining the overlying Rosebud seam.

B. HYDROLOGY

The hydrologic impacts section addresses the influence of both existing and proposed mining on the groundwater and surface water flow, quality, and use within the hydrologic study area. This section examines the anticipated impacts for the five-year mine plan period in Area C, Block I and considers Rosebud Mine Areas A, B, C, D, and E and Peabody's Big Sky Mine, with respect to cumulative impacts on groundwater use and surface water flow and quality.

The following subject areas generally follow the topical organization presented in the baseline environment hydrology section (Chapter II, Section B).

1. Groundwater

The purpose of the groundwater section is to specifically address the influence that existing and proposed mining activities would have on the quantity and quality of groundwater, either originating in or flowing through the hydrologic study area. The potential for impacts by disturbing the groundwater flow system are straightforward. It must be determined: 1) whether or not mining would deplete or contaminate aquifers to the extent that it will affect existing or future users of groundwater; or 2) if groundwater discharge to surface water would be depleted or contaminated to the extent where the potential for surface water use is affected.

a. Groundwater Flow

1) Aquifer Properties

The spoiling of Rosebud overburden and removal of the Rosebud coal would modify hydraulic properties in the Rosebud Mine area. As a result of rubblizing the Rosebud overburden, the porosity of the backfilled material would be double that of the original material. The post-mining increase in effective porosity would allow for increased groundwater storage. However, this increase in effective porosity would also result in the slight retardation of the recovery of groundwater levels. Horizontal hydraulic conductivities of spoiled materials would be equivalent to pre-existing horizontal hydraulic conductivities. However, vertical hydraulic conductivity values would increase significantly from pre-mining values, and would be equivalent to horizontal hydraulic conductivities. The high vertical hydraulic conductivities would increase the potential for post-mining groundwater recharge.

2) Groundwater Movement in Water-Bearing Strata

A regional, three-dimensional computer modeling effort was undertaken for this study because of the complex nature of the hydrologic study area. The geology consists of multiple thicknesses of geologic strata with variable hydraulic properties, cut by surface water drainages. Superimposed on this system are the five mine areas at the Rosebud Mine (A, B, C, D, and E) and the Big Sky Mine. Mining is in various

various stages of progress in four of these areas: Rosebud A, B, and E, and Big Sky. The model has been used to depict the changes in the groundwater flow system as a consequence of both existing and proposed mining through the mine Area C five-year mine life.

The model has allowed for a computation of changes in the groundwater system as existing pits are backfilled (slowly resaturating), while new pits opened (causing localized lowering of water levels).

Inflow to the Area C, Block I pit has been estimated as less than 125 gallons per minute (gpm) for each 14,000-foot pit using the method described by McWhorter (1980). The result of modeling for maximum pit inflow produced a "worst-case" inflow rate estimate of 110 to 120 gpm for a 14,000 linear foot pit. This quantity of flow into a large pit is not significant, and evaporates on pit walls before it can be collected.

Table III-2 shows the ranges of "worst case" results obtained by computer modeling for each mine area. The table presents the amount of drawdown at various distances from pit centers for each mine area for the five-year Area C mine plan. It can be seen that drawdown is usually small at a distance of 2,000 feet for any given year, except where the 2,000-foot radius represents previously mined and spoiled acreage (e.g., mine Area E). Actually, this manifestation is not drawdown, but rather, a slow recovery of water levels in spoils after mining.

The only water-bearing unit of significance that will be affected by mining is the Rosebud coal. The Rosebud overburden and interburden would be impacted by mining, but neither stratum is consistently saturated; thus, the impact on these strata is not significant.

3) Recharge/Discharge Relationships

The impacts to be addressed within a discussion of recharge/discharge are: 1) whether or not recharge to the aquifer would be significantly impaired during the five-year mine plan life, and 2) whether or not there would be a significant change in the rates of discharge to surface water that would diminish surface water flow.

As stated in the description of the existing hydrologic environment (Chapter II, Section B), Rosebud Mine Area C is a regional recharge zone. A majority of East Fork Armells Creek above Colstrip receives groundwater (bedrock) discharge as do the coulees tributary to Rosebud Creek farther to the south.

The potential for impacts on recharge, particularly in Area C, can be gauged indirectly by examining the influence of mining on the potentiometric surface in the recharge zone. A computer program was used to determine that where Area C would be mined, there would be a maximum drawdown of 72 feet with a maximum radius of significant influence of 6,000 feet (Table III-2). This suggests that at some future time recharge loss will be reflected in the groundwater flow system.

A reasonable measure of changes in recharge, at least for the five-year mining period, may be changes in discharge. Table III-3 shows a comparison, based upon results of computer modeling, of changes in

TABLE III-2

DRAWDOWN EFFECTS OF MINING ROSEBUD OVERBURDEN
AND ROSEBUD COAL SEAM, 1983-1987
(in vertical feet)
ROSEBUD MINE AREA, MONTANA

Rosebud Mine Area	Year	Distance From Pit (in feet) 0	2,000	4,000	6,000
A	1983	M	NP	NP	NP
	1984	30	2-3	0.0-1.0	0
	1985	26	4-6	0.5-1.0	0
	1986	23	5-10	1.0-2.0	0
	1987	22	5-10	2-3	0
B	1983	M	NP	NP	NP
	1984*	80	10-15	1.5-3.0	0.0-1.0
	1985	64	2-4	0.0-1.0	0
	1986	56	4-6	1-2	0.0-1.0
	1987	50	45-50	10-15	2-4
C	1983	50	4-6	0.5-1.0	0
	1984	72	2-5	0.5-1.0	0
	1985	72	5-7	0.0-2.0	0.0-1.0
	1986	72	5-10	1-3	0.0-1.0
	1987	72	5-10	3-4	0
D	1983	M	NP	NP	NP
	1984	46	20-25	0-0.2	0
	1985	34	15-20	1.0-2.0	0
	1986	28	15-20	2-3	0.0-1.0
	1987	24	15-20	3.0-4.0-	0.0-1.0
E	1983	M	NP	NP	NP
	1984	55	50-55	5-7	0.5-0.9
	1985	45	40-45	5-10	1.0-2.0
	1986	40	35-40	10-15	2.0-3.0
	1987	35	30-35	10-15	3.0-5.0
Big Sky Mine	1983	25	4-6	0.0-1.0	0
	1984*	24	4-6	0.0-2.0	0.0-1.0
	1985	23.5	5-10	1.0-3.0	0.0-1.0
	1986	22.6	5-10	2.0-3.0	0.0-2.0
	1987	20.8	5-10	2.0-4.0	1-3

M - Mined (aquifer has been affected by mining)

NP - Not Predicted

* Combined effect from Western Energy and Peabody Coal Company operations

TABLE III-3

GROUNDWATER DISCHARGE
MINING IMPACTS TO SURFACE DRAINAGES
(1983 and 1987)
ROSEBUD MINE AREA, MONTANA

Drainage Area	Discharge (in cubic feet per day) 1983	1987	% Change
Coal Bank Coulee	1,532	1,537	+0.003
East Fork Armells Creek	20,605	19,501	-0.05
Hay Coulee	4,586	4,591	+0.001
Lee Coulee	6,927	6.941	+0.002
Miller Coulee	4,572	4,578	+0.003
North Fork Cow Creek	14,500	14,500	0
Pony Creek	8,500	8,500	0
Richard Coulee	9,490	9,490	0
Rosebud Creek	33,172	33,173	0
South Fork Cow Creek	1,238	1,238	0
Stocker Creek	21,208	21,684	+0.02
Unnamed Coulee	3,737	3,737	0

groundwater discharge rates for each drainage area between 1983 (pre-mining effects) and 1987. The results show that no influences are seen within the mine plan period. A decline in water levels within a recharge area may cause some noticeable changes in discharge at some time. Despite increased evapotranspiration accompanying revegetation, the potential recharge capacity of the spoils would be higher than that of pre-mining conditions in Area C. As water levels in the Rosebud coal recover, the long-term impact of mining Area C may be to increase recharge at some future time. This may, in turn, increase flow in the Rosebud aquifer.

4) Groundwater/Surface Water Relationships

The potential for impact to surface water/groundwater communication has been discussed in the previous section. Table III-3 shows the lack of influence of mining on discharge. The maximum change in flow for East Fork Armells Creek and Stocker Creek has been estimated. The result shows a decrease of ten acre-feet per year in East Fork Armells and a net gain of four acre-feet per year in Stocker Creek.

b. Groundwater Quality

1) Valley Fill

Mining in the Rosebud Mine area would, over time, modify the water quality of valley fill material adjacent to spoils materials (refer to Figure II-15). The water quality of the spoils material from mining in Area C is also predicted to change the water quality in valley fill aquifers adjacent to Area C. Waters discharging from the spoils aquifer would recharge the adjacent valley fill of East Fork Armells Creek and Stocker Creek. The TDS concentration in the valley fill of East Fork Armells Creek presently ranges from 1,600 to 2,300 mg/l. Over time, the recharge from the spoils would increase the TDS concentration in the valley fill material to approximately 2,500 to 5,000 mg/l, as is presently seen in the valley fill adjacent to the spoils in Areas A and B.

There would be very little impact from spoils water discharge to Stocker Creek valley fill because the existing TDS values for Stocker Creek valley fill groundwater are equivalent to predicted spoils water TDS values. TDS values farther downstream in the valley fill of Stocker Creek presently range from 1,600 to 1,800 mg/l due to dilution by bedrock groundwater inflow from the west. Since this dilution effect should continue, the overall valley fill water quality should not change as a consequence of mining in Area C.

2) Rosebud Overburden

In order to estimate the quality of Rosebud spoils water, a relationship was established between electrical conductivity* of extracts from the Rosebud overburden and actual TDS values for spoils groundwater located in mine Areas A, B, and E.

*Indicates the first appearance of a term defined in the Hydrology Glossary.

TDS values were calculated for 26 bore hole extract composite EC values in Area C using the determined relationship and the TDS values obtained ranged from 1,600 to 8,800 mg/l. The highest TDS values occurred where the ratio of shale and clay to sand in Rosebud overburden material is highest. The average calculated TDS values for spoils water in Sections 1, 2, and 3 (from east to west) in Area C, Block I are 2,400, 2,500, and 5,200 mg/l, respectively, and compare favorably to measured TDS values from spoils wells in Areas A, B, and E, which range from 1,700 to 5,000 mg/l.

When post-mining hydrologic conditions have stabilized, it is estimated that the TDS concentration in the spoils water would be about twice the present TDS concentration measured in the overburden/Rosebud system.

3) Rosebud Coal

This water-bearing unit would be essentially removed in Area C, Block I, except for the areas underlying the sandstone ridge. This pocket of coal would be isolated from the original recharge areas, and would receive recharge from the surrounding spoils in the future. With time, the better quality water in this pocket of Rosebud coal would be replaced by spoils water and would eventually become indistinguishable from spoils water.

4) Rosebud/McKay Interburden

The spoils aquifer in Area C would be in direct contact with the interburden and mixing may take place in localized areas because of potentiometric head differences. Areas of increased TDS in the interburden caused by spoils water would disperse through the unit with time.

5) Deeper Aquifers

Because of differences in potentiometric head, lower aquifers should not be impacted by mining in Area C.

c. Water Use

1) Water Quality

Mining within the hydrologic study area has the potential for impacting present and future users of the groundwater resource. Mining would actually remove most existing wells and springs and would have drawdown effects on several others in the Rosebud Mine area. The dewatering effects of mining can cause a drawdown of the potentiometric surface. Wells would still penetrate the water-bearing unit, but the dewatering results in a greater depth to water.

Table III-4 lists the affected wells and springs that lie within the hydraulic area of influence, as calculated by Ertec's computer model. The table also shows the maximum possible drawdown throughout the life of the mine for affected wells and springs. It should be noted that the existence of some of these wells and springs is suspect.

TDS values were calculated for 26 bore hole extract composite EC values in Area C using the determined relationship and the TDS values obtained ranged from 1,600 to 8,800 mg/l. The highest TDS values occurred where the ratio of shale and clay to sand in Rosebud overburden material is highest. The average calculated TDS values for spoils water in Sections 1, 2, and 3 (from east to west) in Area C, Block I are 2,400, 2,500, and 5,200 mg/l, respectively, and compare favorably to measured TDS values from spoils wells in Areas A, B, and E, which range from 1,700 to 5,000 mg/l.

When post-mining hydrologic conditions have stabilized, it is estimated that the TDS concentration in the spoils water would be about twice the present TDS concentration measured in the overburden/Rosebud system.

3) Rosebud Coal

This water-bearing unit would be essentially removed in Area C, Block I, except for the areas underlying the sandstone ridge. This pocket of coal would be isolated from the original recharge areas, and would receive recharge from the surrounding spoils in the future. With time, the better quality water in this pocket of Rosebud coal would be replaced by spoils water and would eventually become indistinguishable from spoils water.

4) Rosebud/McKay Interburden

The spoils aquifer in Area C would be in direct contact with the interburden and mixing may take place in localized areas because of potentiometric head differences. Areas of increased TDS in the interburden caused by spoils water would disperse through the unit with time.

5) Deeper Aquifers

Because of differences in potentiometric head, lower aquifers should not be impacted by mining in Area C.

c. Water Use

1) Water Quality

Mining within the hydrologic study area has the potential for impacting present and future users of the groundwater resource. Mining would actually remove most existing wells and springs and would have drawdown effects on several others in the Rosebud Mine area. The dewatering effects of mining can cause a drawdown of the potentiometric surface. Wells would still penetrate the water-bearing unit, but the dewatering results in a greater depth to water.

Table III-4 lists the affected wells and springs that lie within the hydraulic area of influence, as calculated by Ertec's computer model. The table also shows the maximum possible drawdown throughout the life of the mine for affected wells and springs. It should be noted that the existence of some of these wells and springs is suspect.

TABLE III-4

WELLS AND SPRINGS AFFECTED BY MINING
(LIFE OF MINE)
ROSEBUD AND BIG SKY MINES
ROSEBUD COUNTY, MONTANA

Area	Well or Spring Designation	Distance from Pit[4] (in feet)	Maximum Estimated Drawdown (in feet)
A	PW-25[1]	0-2000	8-13
	W.R. #42KJ-W-039569-00[2]	0-200	12-17
	(none)	2000-4000	
	(none)	4000-6000	
B	PW-4111	0-2000	28-33
	W.R. #42KJ-W-039568-00[2]	0-2000	28-33
	W.R. #42KJ-W-039570-00[2]	0-2000	28-33
	PW-40[1]	2000-4000	20-25
	PW-42[3]	2000-4000	10-15
	W.R. #42KJ-C-015835-00[3]	2000-4000	24-29
	PW-39[1]	4000-6000	9-14
	W.R. #42KJ-C-000589-00[3]	4000-6000	3-8
	W.R. #42KJ-C-000872-00[3]	4000-6000	10-15
	SP-06[3]	4000-6000	5-10
C	PW-03[1]	0-2000	20-25
	PW-04[1]	0-2000	5-10
	PW-31[1]	0-2000	20-25
	SP-02[1]	0-2000	15-20
	SP-19[1]	0-2000	25-30
	SP-20[3]	0-2000	25-30
	PW-32[2]	2000-4000	0-5
	SP-01[1]	2000-4000	5-10
	PW-19[3]	4000-6000	0-5
D	(none)	0-2000	
	(none)	2000-4000	
	W.R. #42A-W-034885-00[3]	4000-6000	0-5
	W.R. #42A-C-000871-00[3]	4000-6000	0-5
	SP-16[3]	4000-6000	0-5
E	(none)	0-2000	--
	(none)	2000-4000	--
	SP-13[3]	4000-6000	7-12

TABLE III-4 (Continued)

Area	Well or Spring Designation	Distance from Pit (in feet)	Maximum Estimated Drawdown (in feet)
Big Sky Mine	(none)	0-2000	--
	PW-45[3]	2000-4000	0-5
	W.R. #42A-C-005968-00[3]	2000-4000	0-5
	W.R. #42A-C-005969-00[3]	2000-4000	2-7
	W.R. #42A-C-008398-00[3]	2000-4000	0-5
	W.R. #42A-W-027336-00[3]	4000-6000	0-5

[1]Will be mined out prior to 1987 and replaced

[2]Will be mined out post-1987 and replaced

[3]Indicates a well or spring that will not be removed by mining

[4]Three radii (2,000, 4,000, and 6,000 feet) were drawn from a point within each pit that would be mined for the year of the greatest effect due to mining (greatest drawdown)

(Refer to Plate B-2 in Technical Support Document for locations of wells and springs.)

TABLE III-4

WELLS AND SPRINGS AFFECTED BY MINING
(LIFE OF MINE)
ROSEBUD AND BIG SKY MINES
ROSEBUD COUNTY, MONTANA

Area	Well or Spring Designation	Distance from Pit[4] (in feet)	Maximum Estimated Drawdown (in feet)
A	PW-25[1]	0-2000	8-13
	W.R. #42KJ-W-039569-00[2]	0-200	12-17
	(none)	2000-4000	
	(none)	4000-6000	
B	PW-4111	0-2000	28-33
	W.R. #42KJ-W-039568-00[2]	0-2000	28-33
	W.R. #42KJ-W-039570-00[2]	0-2000	28-33
	PW-40[1]	2000-4000	20-25
	PW-42[3]	2000-4000	10-15
	W.R. #42KJ-C-015835-00[3]	2000-4000	24-29
	PW-39[1]	4000-6000	9-14
	W.R. #42KJ-C-000589-00[3]	4000-6000	3-8
	W.R. #42KJ-C-000872-00[3]	4000-6000	10-15
	SP-06[3]	4000-6000	5-10
C	PW-03[1]	0-2000	20-25
	PW-04[1]	0-2000	5-10
	PW-31[1]	0-2000	20-25
	SP-02[1]	0-2000	15-20
	SP-19[1]	0-2000	25-30
	SP-20[3]	0-2000	25-30
	PW-32[2]	2000-4000	0-5
	SP-01[1]	2000-4000	5-10
	PW-19[3]	4000-6000	0-5
D	(none)	0-2000	
	(none)	2000-4000	
	W.R. #42A-W-034885-00[3]	4000-6000	0-5
	W.R. #42A-C-00087 1-00[3]	4000-6000	0-5
	SP-16[3]	4000-6000	0-5
E	(none)	0-2000	--
	(none)	2000-4000	--
	SP-13[3]	4000-6000	7-12

TABLE III-4 (Continued)

Area	Well or Spring Designation	Distance from Pit (in feet)	Maximum Estimated Drawdown (in feet)
Big Sky Mine	(none)	0-2000	--
	PW-45[3]	2000-4000	0-5
	W.R. #42A-C-005968-00[3]	2000-4000	0-5
	W.R. #42A-C-005969-00[3]	2000-4000	2-7
	W.R. #42A-C-008398-00[3]	2000-4000	0-5
	W.R. #42A-W-027336-00[3]	4000-6000	0-5

[1]Will be mined out prior to 1987 and replaced

[2]Will be mined out post-1987 and replaced

[3]Indicates a well or spring that will not be removed by mining

[4]Three radii (2,000, 4,000, and 6,000 feet) were drawn from a point within each pit that would be mined for the year of the greatest effect due to mining (greatest drawdown)

(Refer to Plate B-2 in Technical Support Document for locations of wells and springs.)

Private wells without water rights designations are numbered as PW; those wells with water rights designations are WR, and developed springs are designated as SP.

Most of the wells and springs would eventually be mined and replaced. Each water well and developed spring lost directly because of mining would be replaced by a well completed in the sub-McKay aquifer.

The results of computer modeling show that twelve water wells and four springs (Table III-4) would not be destroyed by mining, but would experience declines in water levels. Although it is difficult to tell the exact influence this water level decline will have on spring flow without a site-specific study, it is possible that the effect of drawdown would be either to diminish flow or dry up these springs.

In the case of the twelve wells, the increased depth to the water level would not dry up the wells, but pumping costs would increase as a result of the pump having to lift water from a greater depth. The following chart summarizes, in a general way, the magnitude of pumping cost increases that may occur in the situation where a well has an original static water level of 150 feet, where the wire-to-water efficiency is maintained at 0.5 and desired discharge is fixed (Anderson, 1979).

Decline in Water Level (in feet)	Kilowatt Hours per 1,000 gallons	Electrical Pumping Costs (in cents per 1,000 gallons)
0	0.942	7.0654
10	1.005	7.54
20	1.07	8.03
30	1.13	8.48

If a value for electrical power of 7.5 cents/kwh is assumed (personal communication, Intermountain Rural Electrical Association), it can be seen that an increase in pumping costs of about 1.5 cents per 1,000 gallons would occur if water levels were drawn down by 30 feet.

For the average water user the change would not be significant because the difference in cost per month would be a matter of a few pennies.

2) Water Quality

a) Valley Fill

Mining in Area C, Block I would result in an increase in TDS concentrations in valley fill water adjacent to mined areas, and would make the water in valley fill material in East Fork Armells Creek and Stocker Creek less suitable for stock watering than at present. However, the

water should still be within the limits of the water quality standards presented in Chapter II (Section B.c.l.).

b) Rosebud Overburden and Rosebud Coal

These aquifers will no longer be avilable for use in Area C, having been replaced by Rosebud spoils. The TDS concentrations predicted for the spoils aquifer will be about twice the concentration in the existing Rosebud overburden, but should be suitable for livestock watering in emergencies, or if no other more suitable water is available (Chapter II, Criteria).

c) Other Aquifers

None of these lower aquifers would be impacted sufficiently to affect their present or future uses.

d. Cumulative Impacts

The inflow of high-concentration spoils water into the valley fill would be expected to migrate farther with time. A rough calculation of seepage velocities in Area C valley fill shows that based upon an average gradient of 0.008, a mean hydraulic conductivity of 120 ft/day and a porosity of 0.2 the velocity of migrating spoils water would be 4.8 ft/day or 1,753 ft/year.

Spoils water migrating into valley fill will be dispersed and diluted. Over time, as several pore volumes of water infiltrate the spoils, the amount of dissolved solids in spoils "leachate" will decrease. The overall result will be that over a fairly long period of time the concentration of spoils "leachate" will decrease until a near equilibrium condition exists. The actual time this process will take is indeterminate without additional data.

As the high-concentration valley fill water derived from Area C meets spoils water, the resulting water quality will be a composite of the individual spoils water quality. Concentrations should not be increased unless the groundwater is being withdrawn in that reach of the valley by subirrigation.

2. Surface Water

Mining in Area C, Block I would be done by dragline excavation after topsoil and subsoil are removed. Excavation of the pits would form a spoils ridge that would be regraded to the approximate original contour using bulldozers and scrapers. Surface drainages would be reconstructed during the regrading process. All surface flows from disturbed areas will be impounded by sediment ponds and traps. Impounded waters would be released within 15 days, in compliance with Montana Pollutant Discharge Elimination System (MPDES) requirements and Montana Department of State Lands Rules and Regulations.

A surface runoff model, HYMO (Hydrologic Model) was combined with a grid model of East Fork Armells Creek and Stocker Creek to describe the pre- and post-mine surface water flow regimes. The HYMO model was

designed for forecasting floods, planning flood prevention projects, and general hydrologic research.

Another model, the grid model, was used to determine input parameters for the HYMO model as well as to forecast pre- and post-mine erosion magnitudes and to compare pre- and post-mine topographies (see Technical Support Document, Section B.3 for details). For the flood routing procedure of the HYMO model, East Fork Armells Creek and Stocker Creek were divided into subbasins (Figure III-1). These subbasins range from 0.14 square miles (mi^2) to 9.63 mi^2 (Table III-5), and have average slopes ranging from 0.038 feet per foot (ft/ft) to 0.109 ft/ft. Stream channels in these subbasins have slopes ranging from 0.003 ft/ft to 0.025 ft/ft. The grid model was used to compute slopes, hydrologic SCS curve numbers, and general soil losses from each subbasin (see Technical Support Document, Section B.3), and for computation of input parameters used in the HYMO model. The results of the grid and HYMO modeling used to predict impacts are presented in the following sections.

a. Reclaimed Drainage Basin Characteristics

The reclaimed drainage basins in Area C would approximate those of the pre-mining environment. A map of Western Energy's proposed subbasins for Area C, Block I is included in the Mine Permit Application. Evidence from existing, reclaimed basins in the Colstrip area suggests that the reclaimed drainage basin characteristics would be strongly influenced by the engineering techniques and equipment used to reclaim the spoils.

The drainage density and network characteristics proposed under the mine plan are similar to those of the pre-mining environment. After reclamation, it is likely that the channel network would expand, creating a higher density of short stream segments formed by headward erosion. Such a development would reflect an adjustment of the channel network to the reclaimed hydrologic system, similar to that observed in the currently reclaimed areas. If proper mitigations are performed, this impact would be minimal.

b. Stream Channel Characteristics

The ephemeral stream channels in Area C will be reestablished with longitudinal profiles and cross sections approximating pre-mining conditions. Plots of the post-mine drainages are presented in the Area C, Block I Mine Permit Application.

As planned by Western Energy, the development of channel profiles that are concave and without knickpoints will decrease the potential for widespread initial instability in the channel. However, both natural and man-induced processes are likely to result in changes to channel geometry, because the reclaimed ephemeral channels in this area will be as inherently unstable as the pre-mine ephemeral channels. The development of gullies can be expected (see Technical Support Document, Section

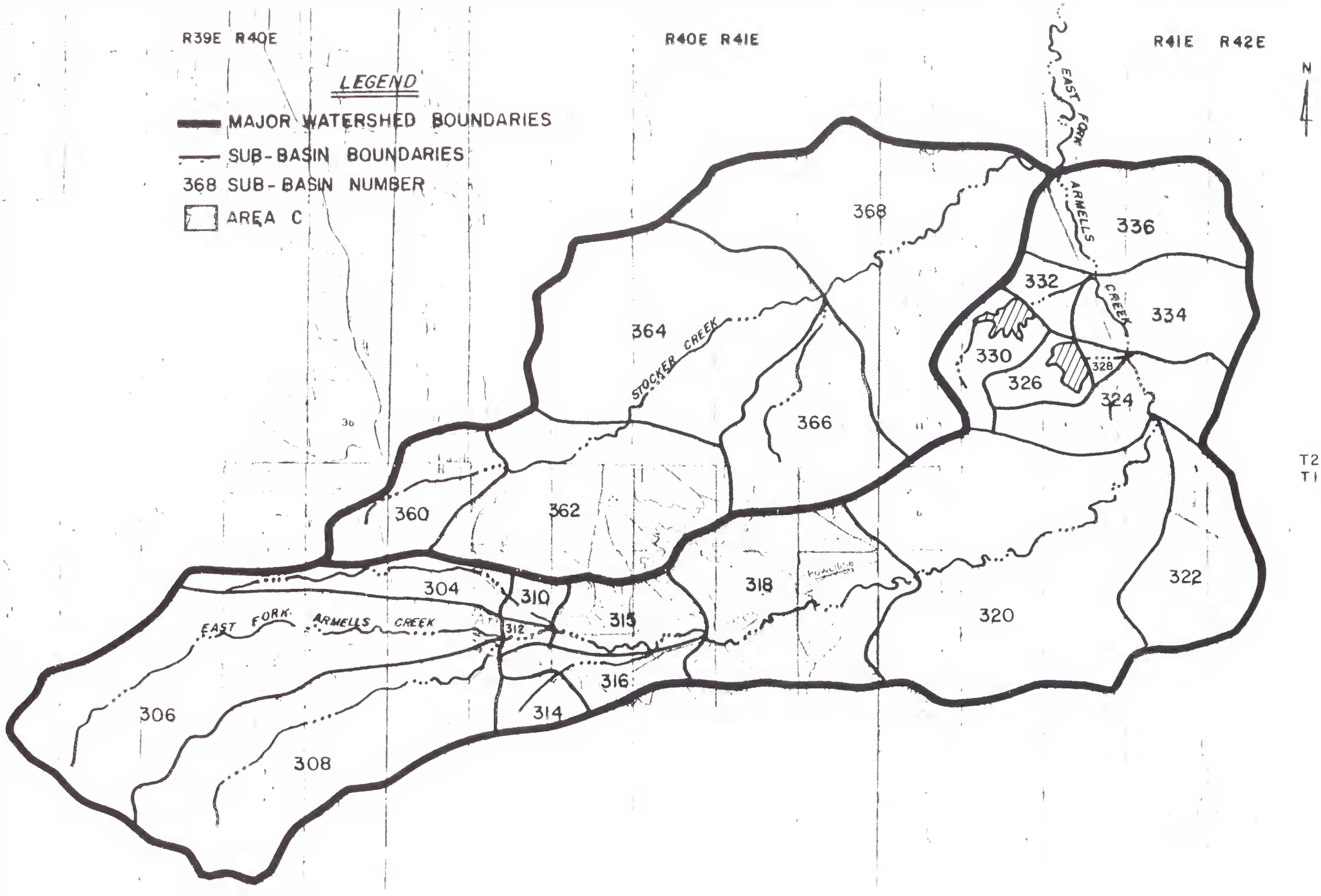


FIGURE III-1 HYDROLOGIC SUB-BASIN MAP, EAST FORK ARMELLS CREEK AND STOCKER CREEK, ROSEBUD MINE, MONTANA

B.4). If left unmitigated, gully development will be a serious impact, but probably no more so than already exists with pre-mine channels.

Under pre-mining conditions, many of the ephemeral channels are strongly influenced by the presence of bedrock at shallow depths (Chapter II, Hydrology, Surface Water). The reclaimed channels, however, will be developed on reclaimed spoils materials, and to a limited extent on the sandstone ridge that will remain in Area C under the present mine plan. These factors may result in the stream channel adjusting to a different geometry.

Perhaps the most significant man-induced influence on the post-mining channels will be the construction of sediment ponds. Upstream of the ponds, changes in channel geometry may be induced by a new base level imposed on the system. This can result in a pattern of cut and fill similar to that observed in the undisturbed channels.

Downstream of the sediment ponds, further changes are likely to occur in response to the reduction of peak flow magnitudes and the removal of sediment by the ponds. There could be two major consequences: channel incision and aggradation*. The result of these changes will be a reduction of the low-flow channel capacity (see Technical Support Document, Section B.4 for details).

If there is frequent intermittent flow in the channel, incision may occur below the dam. This impact is considered insignificant considering the relatively short (10 to 20 years) life of the sediment ponds. However, if the ponds are to become permanent, this impact will become greater, possibly causing a lowering of base level downstream.

The most significant impact of the sediment ponds is likely to occur after reclamation, when the ponds are removed and the undersized, aggraded channels are again subjected to uncontrolled discharges from the basins. The probable effect will be an episode of high erosion and downstream sedimentation accompanying entrenchment of the main channel.

c. Basin Sediment Yields and Geomorphic Stability

On a large scale, the proposed reclaimed landscape appears to be stable, although increased rates of erosion may be associated with problems of subsidence or differential erosion at the highwall interface (see Geology, Section A).

The Universal Soil Loss Equation (see Technical Support Document, Section B.4) was applied to the grid model to predict post-mine erosion rates* in the basins and to compare these rates to pre-mining erosion. Results indicate that in general the post-mine erosion rates would be very close to, or slightly less than, pre-mining conditions. This is mainly due to the elimination of short, steep slopes in reclamation and an increase in vegetative cover, assuming reclamation is successful (Vegetation, Section G).

Figure III-2 illustrates the general post-mine erosion surface, showing the relative magnitudes of erosion rates. Figure III-3 illustrates those areas where the post-mine erosion rates exceed those of the pre-mining environment. Erosion rates during mining, however, can be expected to be greater than those in the pre-mining environment. Those areas where post-mine erosion is greater than pre-mine erosion were located along the permit boundaries in areas where post-mine slopes were greater than pre-mine slopes (Figure III-3). These areas, if properly stabilized, should not cause a serious impact. Basin sediment yields or the actual amount of sediment moved out of the basin, however, would be considerably less than the erosion rate due to deposition of eroded material while in transit. Sediment yields would be highly dependent on the efficiency of the reclaimed channels in transporting sediment.

Area-wide settling is common in most post-mining landscapes and occurs during the first ten years after the completion of contouring. A swell factor of 22 percent has been assumed for mine spoils in the Area C, Block I mine plan. With time, these materials would settle and approach a density similar to that which existed prior to mining. Groenweld and Rehm (1980) indicate that there would be less settlement and it would occur more rapidly with sandy material as compared to silty material. Settlement is likely to be less significant at Colstrip than in many other sites because of the sandy character of the spoils.

Piping is a phenomenon associated with subsidence and may be a severe and long-term problem in the post-mine landscape. At the surface or near-surface, piping begins as a crack either in the surface of the exposed spoils or at the topsoil/spoil interface, allowing surface runoff to flow into the sub-surface of the spoils. However, surface cracking would not always result in the development of piping. Piping is most likely to occur when an avenue for potential water movement is present in the subsurface of the spoils. Such an avenue of flow can result from fracturing within the spoils due to settling between differentially compacted areas, or within areas of poorly compacted spoils. Such differential settlement is most likely at the highwall interface between coherent overburden and the spoils materials, and between areas of spoils handled by different equipment. If left unmitigated, piping and the consequent gullying it causes would be a serious impact to the stability of the reclaimed landscape.

d. Flow Rate Analysis

The HYMO model was used to compare pre- and post-mine surface flows. Surface flows occurring during mining were not evaluated quantitatively due to the changing nature of the drainages as reclamation progresses. One of the impacts on surface flows during mining is attenuation of peak flows due to the impoundment of snowmelt and storm runoff in the sediment ponds. This impact would also cause base flow to be prolonged slightly due to the gradual release of flow from the ponds after treatment. The major impact to surface flows during mining, however, would be a decrease in total volume of flow from the mined

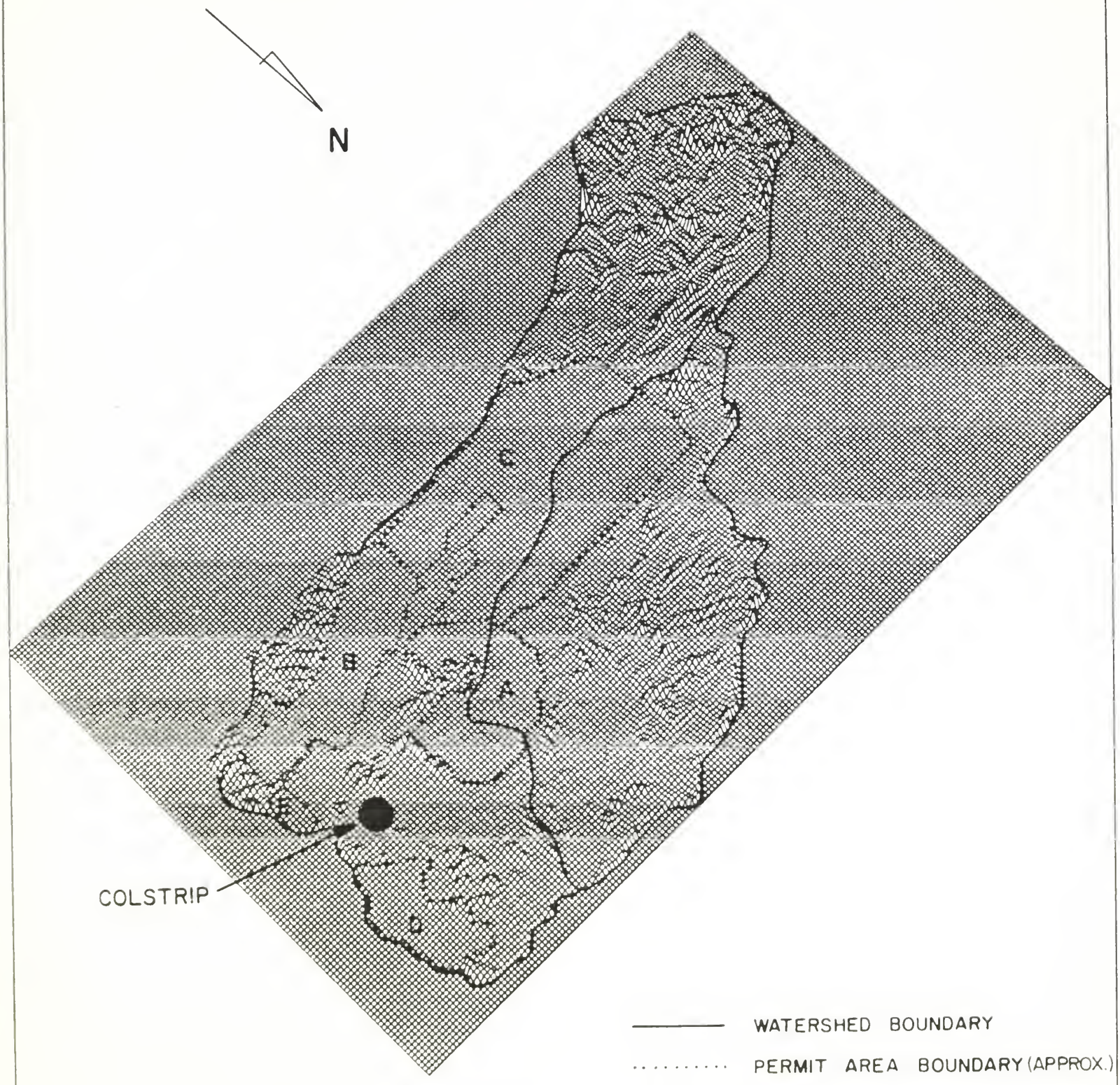


FIGURE III-2

COMPUTER-GENERATED POST-MINE EROSIONAL SURFACE, ROSEBUD MINE

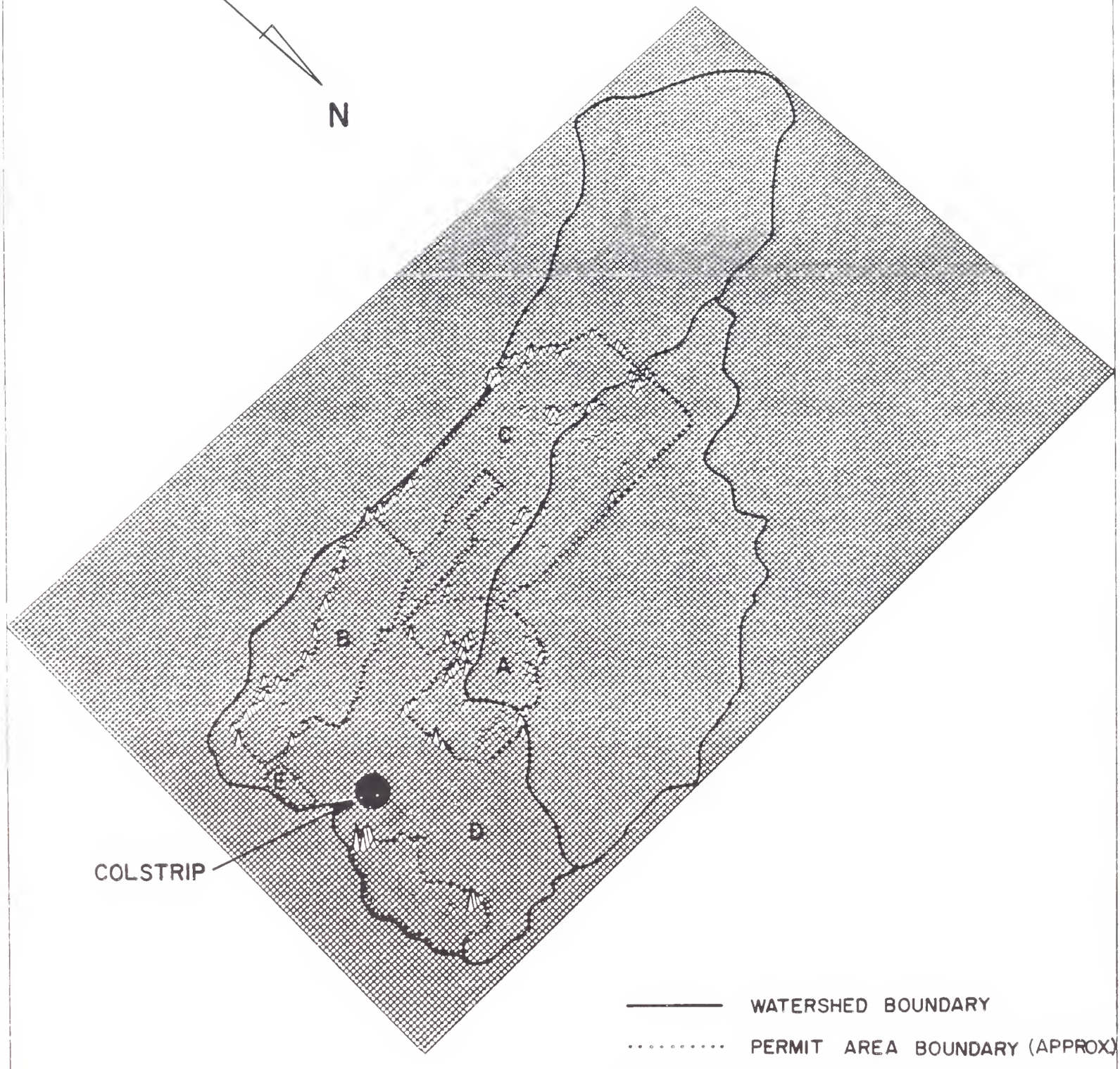


FIGURE III-3

COMPUTER-GENERATED POST-MINE EROSIONAL SURFACE, ROSEBUD MINE, WHERE POST-MINE EROSION EXCEEDS PRE-MINE EROSION

areas due to increased evaporation and seepage from the sediment ponds and the use of sediment pond water for dust suppression. Since the disturbed area of Area C, Block I is approximately six percent of the combined Stocker Creek and East Fork Armells Creek drainages at their confluence, this is not considered a major impact.

Post-mine flow volumes and peak flows would be slightly reduced assuming that reclamation is successful, due to a slight increase in vegetation densities and infiltration rates. Tables III-6 and III-7 illustrate this difference between pre- and post-mining surface flows. Sediment ponds will have only a minor effect on the post-mine surface flow regime since most or all of these would be removed when the reclamation bond is released.

e. Water Use

Surface water use in the Colstrip area would be relatively unaffected by mining in Area C, Block I due to the small (six percent) amount of the total drainage area affected. Slightly less water would be available for stock ponds during mining as a result of sediment impoundments and the resulting loss from seepage and evaporation; however, the water quality in the ponds should be the same as present water quality and would be suitable for present-day use.

Flood irrigation downstream from the townsite of Colstrip would likewise be little affected by Area C, Block I mining. Stream flow is used for irrigation only during periods of high flow when adequate quantities are available and the quality is good. This would continue to be the situation after mining and the water quality should be about the same. Water quality during low flow periods is suitable for livestock watering, and would remain so after mining. During mining, sediment ponds would cause peak flow attenuation that may have short-term affects on flood irrigation. Long-term effects (post-bond release) should be negligible, although a decrease in flow volume and peak flows is expected.

All springs issuing from the spoils of Area C and other springs presently in Area C will be suitable for livestock watering.

f. Water Quality

1) Streams

Water flowing across the surface of the reclaimed Area C as a result of a storm or snowmelt runoff would have much lower TDS values than, for example, spoils water. This is because earth/water contact time is relatively short during runoff and the surface soils would be leached of soluble salts.

Water discharging from the mined area directly to streams during high flow should have a very small impact on stream quality. Sediment loads during high flows have been addressed in Section B.2.c and are not repeated here.

TABLE III-5
SUBBASIN PARAMETERS, STOCKER CREEK
AND EAST FORK ARMELLS CREEK

Sub-basin Number	Area (Mi^2)	Pre-Mine Basin Slope (ft/ft)	Post-Mine Basin Slope (ft/ft)	Reach Length (mi)	Average Reach Slope (ft/ft)	Average Length Overland Flow (ft)	Pre-Mine Hydrologic Curve No.	Post-Mine Hydrologic Curve No.
EAST FORK ARMELLS CREEK								
304	1.43	0.048	0.050	4.14	0.023	347	79	76
306	7.84	0.109	0.109	8.42	0.022	425	71	71
308	6.43	0.100	0.100	5.98	0.025	381	73	73
310	0.38	0.066	0.070	0.59	0.010	347	79	61
312	0.14	0.043	0.045	0.87	0.008	425	75	61
314	0.74	0.038	0.040	1.04	0.024	356	75	74
315	1.58	0.042	0.046	3.28	0.004	430	76	61
316	1.18	0.047	0.050	2.20	0.008	473	73	62
318	5.20	0.045	0.043	4.93	0.004	637	69	63
320	9.63	0.049	0.047	6.47	0.004	764	73	69
322	2.92	0.054	0.053	3.09	0.018	731	73	69
324	2.07	0.048	0.048	1.34	0.004	461	74	71
326	0.86	0.052	0.054	1.04	0.020	312	72	67
328	0.14	0.044	0.044	0.47	0.016	272	69	69
330	1.06	0.049	0.055	1.93	0.022	259	76	67
332	0.73	0.057	0.057	1.10	0.014	398	74	74
334	2.33	0.064	0.061	1.70	0.004	408	71	66
336	3.06	0.058	0.058	2.27	0.003	293	77	74
Total	47.72	0.067	0.066	29.28	0.009	429	73	69
STOCKER CREEK								
360	1.99	0.049	0.050	2.62	0.016	601	69	68
362	5.10	0.046	0.048	1.98	0.008	566	72	64
364	6.80	0.059	0.059	3.84	0.006	439	76	76
366	3.63	0.058	0.058	2.51	0.013	421	71	68
368	8.59	0.054	0.054	5.48	0.004	375	76	74
Total	26.11	0.054	0.054	13.92	0.007	480	74	71
Combined	73.83	0.062	0.062	---	---	---	73	70

TABLE III-6
PRE- AND POST-MINE PEAK FLOWS
(in cubic feet per second)

	Recurrence Interval (Years)											
	2		5		10		25		50		100	
	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-
East Fork Armells Creek at Stocker Creek (47.72 sq.mi.)	326	230	708	557	1070	880	1670	1430	2100	1840	2550	2260
Stocker Creek (26.11 sq. mi.)	218	163	457	302	676	583	1030	919	1280	1160	1540	1400
East Fork Armells Creek below Stocker Creek (73.83 sq. mi.)	541	391	1160	935	1740	1460	2700	2350	3380	2990	4090	3670

TABLE III-7
PRE- AND POST-MINE SURFACE FLOW VOLUMES
(in acre feet)

	Recurrence Interval (Years)											
	2		5		10		25		50		100	
	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-
East Fork Armells Creek at Stocker Creek (47.72 sq. mi.)	292	190	725	536	1170	912	1960	1600	2550	2130	3183	2700
Stocker Creek (26.11 sq. mi.)	196	147	464	375	733	612	1210	1040	1560	1360	1930	1710
East Fork Armells Creek below Stocker Creek (73.83 sq. mi.)	488	337	1190	911	1900	1520	3170	2640	4110	3490	5110	4410

See Technical Support Document for detail

During low flow conditions, any flow is predominantly groundwater from the valley fill. Existing average low-flow TDS values for drainages in the hydrologic study area are in the same range with predicted spoils water TDS values. Consequently, the influence of spoils water on base flow surface water would not be significant.

2) Ponds

The three ponds in Area C, Block I (see Figure III-4) will be removed during mining. When the ponds are restored in the reclaimed mine area, the water quality is expected to be generally the same as the present pond quality. During precipitation events, low concentration water will be stored. This water will evaporate and increase in concentration with time, as it does under present conditions. The impact of sedimentation on ponds is covered in Section B.2.c.

3) Springs

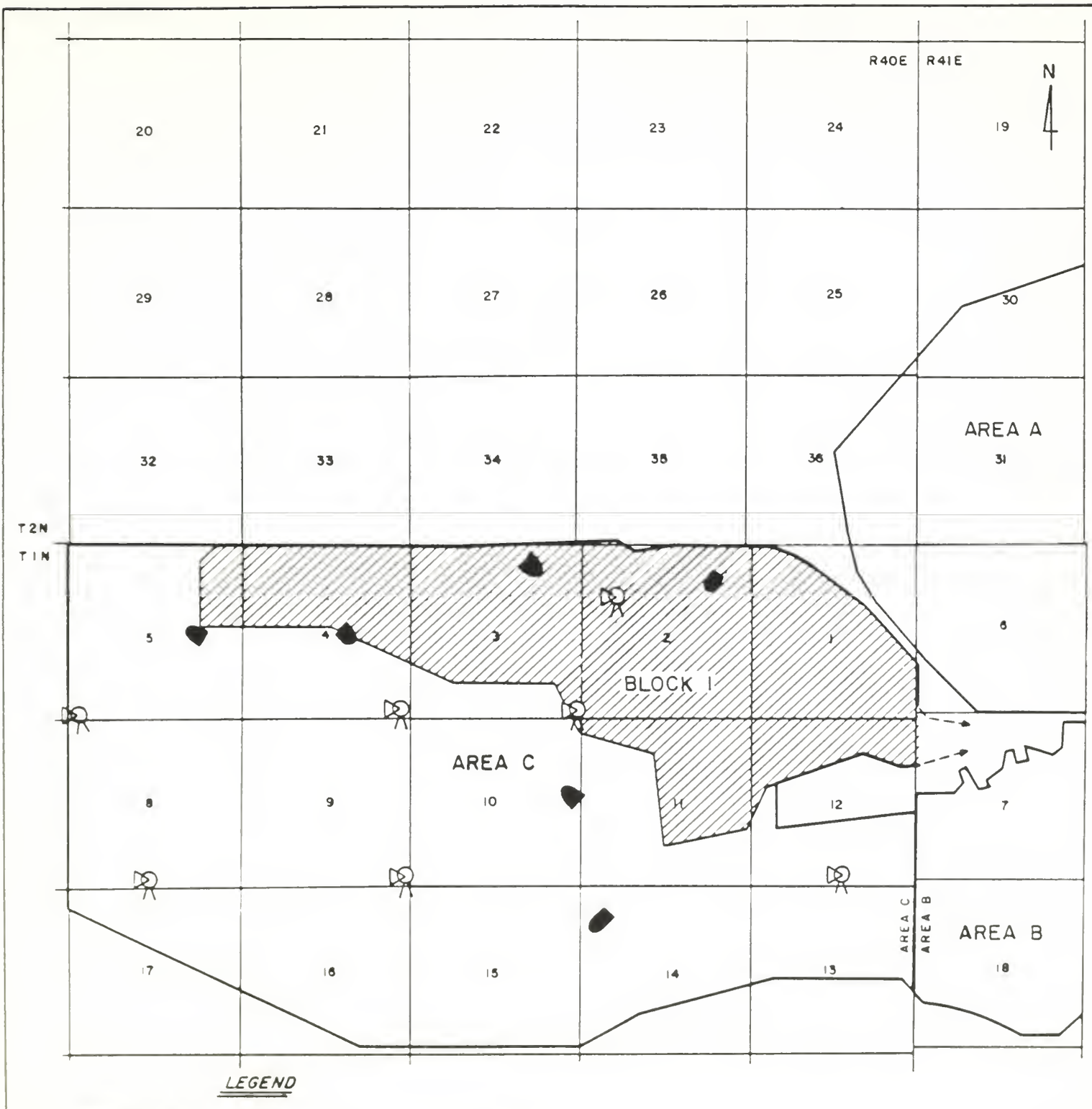
Springs in Area C have TDS concentrations ranging from 3,000 to 5,000 mg/l, with the exception of spring SP-02, which has a TDS value of 470 mg/l. This spring would be interrupted or destroyed when Area C is mined. If it flows after mining, it would probably have a TDS concentration similar to the other springs in the area (3,000 to 5,000 mg/l). Any new springs issuing from the mined area would also have TDS concentrations similar to the other springs in the area.

g. Cumulative Impacts

The cumulative surface water hydrology impacts from mining are insignificant. The post-mine sediment yield and peak flow suggest in the long-term (greater than 20 years after mining) the proposed post-mine topography would be geomorphically stable. This conclusion assumes that revegetation would be successful, post-mine drainage channels are adequately designed, and that major deviations in the proposed post-mine topography would not occur. This assessment is based on various techniques, including a computer simulation (Technical Support Document, Sections B.3 and B.4) of surface runoff and sediment yield analysis of pre- and post-mine conditions, using slope, soils, vegetation, drainage density, and precipitation events as the variable features.

The amount of water imported to the Colstrip area would increase along with the expansion of the Montana Power Company power plants and the consequent increase in population. Water discharge to East Fork Armells Creek would also increase if present sewage treatment practices continue. These increases could cause a rise in the local water table, which, in turn, could have possible detrimental downstream effects.

Any cumulative impact on stream quality would be very insignificant. Overland flow from reclaimed mine areas directly to streams during snowmelt and storm runoff events is expected to be the same or possibly better quality than under present conditions, and thus would have no impact on stream quality. Groundwater inflow to the streams from the



LEGEND

AREA C, BLOCK I SCALE: 1"=4550'

WELL EQUIPPED WITH WINDMILL, 1 gpm
(WELLS ASSUMED TO BE DRILLED TO SUB-McKAY LEVELS)

STOCK POND, APPROX. 5 ACRE FEET

SOURCE: WESTERN ENERGY COMPANY (THESE PROPOSED LOCATIONS HAVE NOT BEEN REVIEWED OR APPROVED BY THE MONTANA DEPT OF STATE LANDS.)

FIGURE III-4 PROPOSED POST-MINE STOCK WATER USE, ROSEBUD MINE AREA, MONTANA

valley fill during low-flow conditions would be the same and possibly slightly more concentrated than at present, but this effect should be slight and not distinguishable from the present variation in stream quality.

C. CLIMATE

The proposed mining of Area C, Block I would not have any impact on the climatic regime in the area.

Ertec evaluated four possible avenues for climatic modification by the project:

1. Major increases in area atmospheric moisture content

2. Changes in surface albedo due to surface disturbance

3. Changes in increasing radiation caused by increased suspended particulate matter

4. Changes in cloud formation caused by increases in condensation nuclei (from suspended particulate matter)

There are no major sources of atmospheric moisture. Increases from vehicular exhaust and evaporation of water used for dust suppression would be very small compared to moisture levels needed to produce climate changes. Only a very small percentage of the disturbed acreage would have a significantly different color than the existing surface. Consequently, surface albedo would not be significantly altered by the project. As documented in the visibility degradation analysis in the air quality section, suspended particulate concentrations would have little effect on light transmission, thus there would be no expected change in incoming solar radiation. Finally, the particulate matter would occur close to the surface, where the availability of condensation nuclei is not the limiting parameter in cloud formations (Wallace and Hobbs, 1977).

D. AIR QUALITY

A mining development such as the proposed Area C operation can impact air quality in several ways:

- o It can increase the ambient concentrations of various pollutants in the air
- o It can increase the rate at which dust or other particulate matter settles on surfaces near the mining operation
- o It can degrade the ambient visibility in the area

In this assessment, an evaluation of each of these effects has been made. The basic methodology is to develop an inventory of the various project-related sources of air pollution emissions and estimate their emission rate. These estimates are then used, together with the meteorological data presented in Chapter II, as input to a mathematical simulation model of atmospheric pollutant behavior. The model provides estimates of increases in ambient concentrations expected from the proposed project. From these concentrations, deposition and visibility degradation can be estimated.

Both the state and federal governments require that proposed new sources be evaluated for potential air quality impacts. Government agencies have established legal limits on pollutant levels (Table II-8). Western Energy has applied for an air quality permit to construct and operate from the Montana Air Quality Bureau (MAQB) for the planned Area C, Block I operations. The MAQB has issued a preliminary determination to issue this permit. The Area C, Block I mining operation would be located on the boundary of a non-attainment area for TSP. Normally, a new project in such a location would be required to comply with the non-attainment provisions of the Clean Air Act amendments of 1977, which are now incorporated in Montana law. The Prevention of Significant Deterioration (PSD) requirements would not apply because Area C, Block I is located in a nonattainment area. The nonattainment regulations require that a source obtain an offsetting reduction in emissions equal to or greater than the proposed project emissions. Also, the new source is required to demonstrate that it will attain the lowest achievable emission rate (LAER). To be subject to the nonattainment review process of the Clean Air Act Amendments, a source must have at least 250 tons per year of nonfugitive emission. Since the nonfugitive emission estimates for the proposed Area C, Block I mining operations do not exceed this limit, the nonattainment review does not apply. However, Section 16.8.1401 of the Montana Air Quaility Rules still requires the LAER must be attained.

The only pollutant of major concern would be particulate matter. By far, the most significant component of the particulate matter emission would be fugitive dust from heavy equipment movement on the unpaved surfaces in and around the mine, and from coal and overburden handling. Major sources would include haul roads, draglines, wind erosion, scrapers, and bulldozers.

Although the crushing and conveying operations would be sources of dust emission, they are not "fugitive" sources since control equipment would be installed on these units to reduce dust emissions.

Additionally, small amounts of particulate matter and gaseous pollutants would originate from the exhaust of diesel equipment used in the mining operation. The most significant of these gaseous pollutants would be oxides of nitrogen (NO_x). Total annual emissions of NO_x are estimated to be 134 tons from diesel equipment and an additional 35 tons from blasting with an ammonium nitrate and fuel oil mixture. This emission rate could be expected to increase ambient nitrogen dioxide (NO_2) concentrations in the project area by a small percentage, but impacts would be restricted to the mine area alone and would be less than 20 percent of the ambient standard for annual-average NO_2 concentrations. Emissions of carbon monoxide (26 tons per year), hydrocarbons (9 tons per year), and sulfur dioxide (9 tons per year) would not constitute a significant impact on the project or regional area. Since these emissions would be small, and would not be likely to create any impact, only fugitive dust emissions are considered.

A summary of the emission inventory prepared by the air quality study team for this EIS (with the coordination and approval of the MAQB) is shown in Table III-8. Details of the computations can be found in the Technical Support Document. The emission inventory refers to emission rates characteristic of those expected if the Area C, Block I operations are in full production.

In addition to the emissions caused directly by the project, there would be secondary emission sources, resulting from the increase in population and services accompanying the project and emissions from other simultaneous new projects in the area. Table III-9 lists the other (nonproject) emission sources and the estimate of annual average emission rates. Emission rates are presented for two years. The year 1980 was selected to be representative of current emission rates while 1988 was selected to represent future conditions. These dates were selected primarily because data were readily available for these years. Details of the computations for these emission rates are presented in the Technical Support Document.

The Ertec Mining Air Quality (EMAQ) model was used to predict ambient concentrations resulting from the proposed Area C, Block I operations. The model is described in detail in the Technical Support Document. It is basically a Gaussian plume-based model that uses particle deposition based on the equations of Ermak (1977). Both annual-average and peak 24-hour average concentrations were calculated. The on-site meteorological data from the train loop station operated by Western Energy was used in the analysis. A full year of readings for the period of January through December, 1980 was sequentially analyzed in this study. Three geographical areas of interest were identified: the area immediately adjacent to the proposed mining operation (hereafter referred to as the mine area), the townsite of Colstrip, and the Northern Cheyenne Indian Reservation (NCIR). The mine area was selected because

TABLE III-8

EMISSION INVENTORY FOR AREA C OPERATIONS

Source	Annual Emission Rates (ton/year)	Maximum Short-term Emission Rates (ton/da
Topsoil Removal	302.00	0.853
Overburden Removal (Dragline)	581.00	2.198
Overburden Blasting	1.20	0.009
Coal Blasting	2.60	0.016
Overburden Drilling	0.35	0.003
Coal Drilling	1.00	0.013
Coal Removal	68.20	0.297
Road Construction and Maintenance	210.00	0.868
Haul Roads - $CaCl_2$	62.20	0.271
Haul Roads - H_2O	100.50	0.438
Access Roads	7.30	0.021
Wind Erosion	555.00	1.521
Bulldozers	53.20	0.201
Emergency Stockpile	1.50	0.064
Coal Dumping*	0.48	0.002
Primary Coal Crushing*	0.56	0.002
Secondary Coal Crushing*	1.68	0.007
Conveyor Transfer Pts.*	5.60	0.024
Coal Screening*	2.80	0.012
Overland Conveyor*	2.52	0.011
TOTAL	1,959.69	6.831

* Not classified as fugitive dust

TABLE III-9

NONPROJECT EMISSIONS

Source	Annual Emission Rate (tons/year) 1980	1988
Other Western Energy Sources		
Area A	2,673	4,115
Area B	3,511	5,366
Area E	2,084	3,210
Peabody Big Sky Mine	1,502	2,426
Colstrip Units 1 and 2		
Stack Emissions	887	1,028
Lowering Wells	3	3
Crushing	1	1
Coal Piles	65	75
Colstrip Units 3 and 4		
Stack Emissions	0	3,582
Lowering Wells	0	6
Crushing	0	2
Coal Piles	0	15
Other Sources	2,927	3,169
TOTAL	13,656	22,998

impacts will be highest there; the town-site of Colstrip was selected because it is currently classified as not being in compliance with the air quality standards, and the NCIR was selected because it is classified by EPA as a Class I area and as such is accorded special consideration.

The analysis of impacts in the mine area is complicated by the presence of both attainment and nonattainment areas (for TSP). Figure III-5 shows isopleths of annual-average TSP concentration predicted to result from the proposed Area C operations. The isopleths include the contribution from both fugitive and nonfugitive emissions. As the figure shows, the proposed operations would increase TSP concentration in both the attainment and nonattainment areas. However, the mining operation would not be required by current Montana laws to include fugitive dust in the impact analysis. Because the nonfugitive dust emissions would be sufficiently small to escape nonattainment review, the mining operation would not be required to make a demonstration of compliance with the emission offset ruling. Since nonattainment and PSD would not apply to this project, the remaining discussion of the impacts does not reference the distinction between the attainment and nonattainment areas. Also, the remaining discussion addresses all particulate matter including both fugitive and nonfugitive emissions.

Table III-10 summarizes the results of the air quality modeling study. The annual-average TSP concentration predictions for the mine area ($11\ ug/m^3$), when added to existing levels of approximately 25 ug/m^3, total 36 ug/m^3. Increased TSP in emissions from nonproject sources in the Colstrip area (see Table III-9) might result in a further increase in the mine area, on the order of 7 ug/m^3. This estimation is based on approximate calculations. Details of this estimate can be found in the Technical Support Document. Thus, total annual-average TSP concentrations in the mine area would rise to approximately 43 ug/m^3. This value is an arithmetic average and still well below the Montana air quality standard of 75 ug/m^3. Federal annual standards are geometric means and are expressed as both primary (75 ug/m^3) and secondary (60 ug/m^3). Since the arithmetic mean is always greater than the geometric mean, we can conclude that the predicted total TSP concentration in the mine area would not exceed federal annual standards.

The impact of the project on annual-average TSP concentrations in the townsite of Colstrip would be very slight. The predicted increase of $1.2\ ug/m^3$ would be less than the detection limit for most monitoring equipment and would be essentially equivalent to the cutoff EPA uses in determining if a source has an insignificant impact on a given receptor. The impact of increases in nonproject emission sources on Colstrip would be far greater. These emissions would be expected to worsen the existing air quality problem in Colstrip.

Annual-average TSP concentrations in the NCIR resulting from the project would be extremely low and can be disregarded completely.

Peak and second highest 24-hour TSP concentrations in the mine area would be around 38 ug/m^3. Existing peak 24-hour TSP concentrations would be around 90 to 100 ug/m^3, but the high impacts from the mining

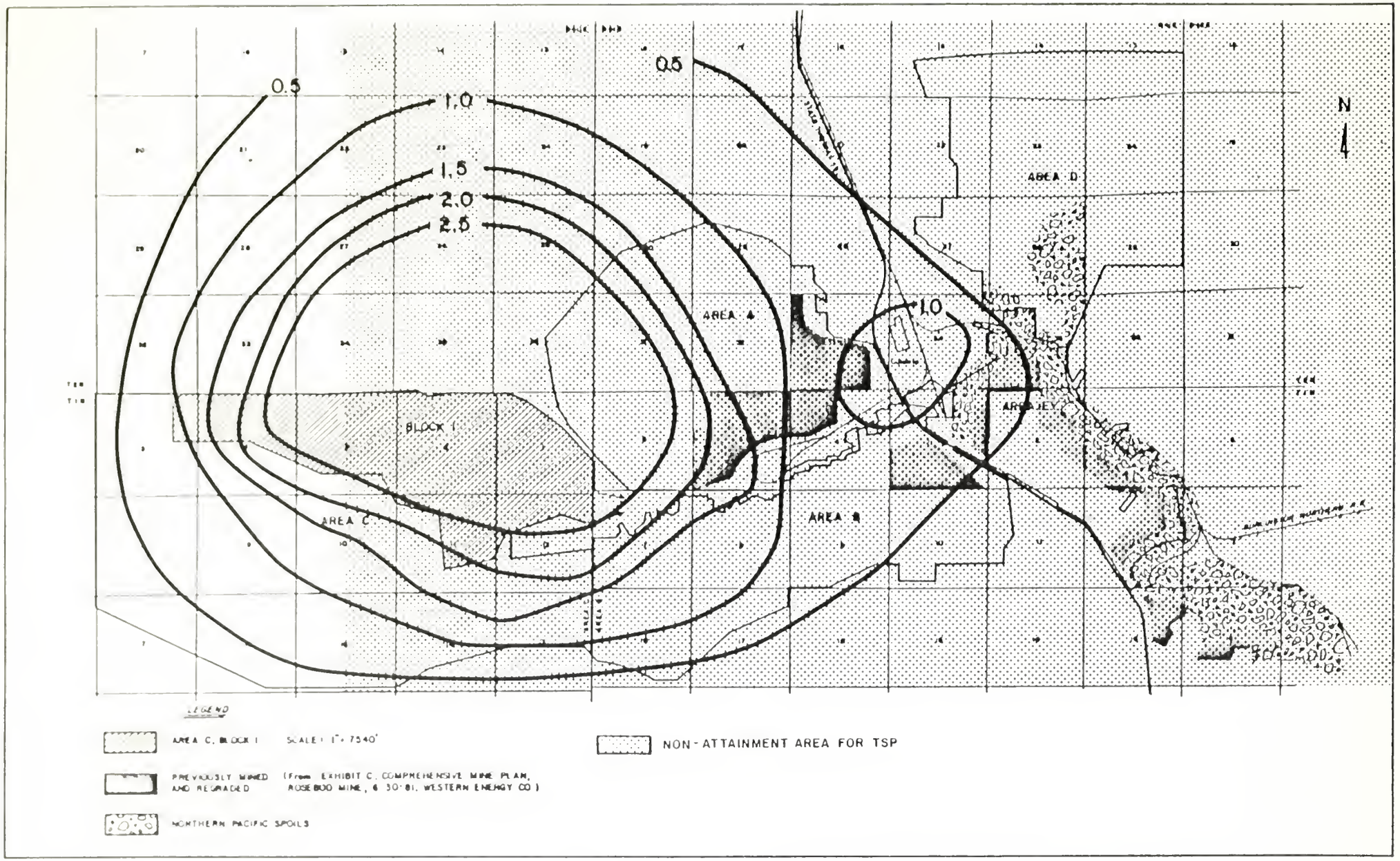


FIGURE III-5 ISOPLETHS OF ANNUAL-AVERAGE TSP CONCENTRATION IN ug/m^3 RESULTING FROM THE AREA C, BLOCK I OPERATIONS ALONE

TABLE III-10

PREDICTED TOTAL SUSPENDED PARTICULATE
CONCENTRATIONS IN MICROGRAMS PER CUBIC METER
RESULTING FROM THE PROPOSED PROJECT

Location	Annual-Average	24-Hour Average	
		Highest	Second Highest
Mine Area	11.50	38.1	30.9
Colstrip	1.20	4.6	4.4
Northern Cheyenne Indian Reservation	0.01 (negligible)	0.3	0.2

operation may not occur under the same meteorological conditions. Even with the worst-case assumption that these peaks overlap, the total value of 138 ug/m^3 would still be below both primary and secondary air quality standards. Impacts from nonproject sources in the area would not cause excursions of the standards at Area C.

The peak 24-hour impact of the mining operation on the townsite of Colstrip (less than 5 ug/m^3) would be inconsequential when compared to the existing peaks that occur there (during 1974 to 1979 Colstrip had measured peaks every year of over 350 ug/m^3). Therefore, the proposed mining operation would not be expected to have a significant impact on 24-hour concentrations in Colstrip. Nonproject emissions in Colstrip would increase 24-hour concentrations.

Peak impacts in the NCIR would be very low; they are not likely to be measurable.

The impacts caused directly by the project would be far below the primary standards, which are designed to protect human health. The townsite of Colstrip would be expected to continue to exceed the primary standard, due primarily to nonproject sources of emission. The high concentrations have not produced a hazard to health in the past primarily because of the high percentage of large particles, which pose less threat to human health than small particles. It is uncertain whether future particulate levels in Colstrip would constitute a health hazard. It is unlikely, however, that the proposed project would be a significant component to any potential threat to human health.

While producing large TSP concentrations, fugitive dust impacts do not pose as great a hazard to health as equivalent concentrations resulting from other sources. This is because much of the measured TSP in the fugitive dust impact is composed of particles greater than 15 micrometers in mass mean diameter. These large particles are removed by nasal hairs and mucous membranes prior to entering the lungs by inhalation. No adverse health effects have been reported from exposure to annual geometric mean TSP concentrations of 86 ug/m^3 in Colstrip during 1974 through 1979 (Montana Department of Health and Environmental Sciences, 1980).

Deposition of particulates in the project area would increase from existing 30-day average levels of approximately 7.4 grams per square meter on an annual-average basis to levels of approximately 8.6 grams per square meter at points separated from the mining operations by at least 500 meters. The 30-day average value for settled particulates regulated by Montana is currently being exceeded throughout much of the Colstrip area, including the project area. This would be expected to continue, and to increase in the project area. Values could be as high as 60 grams per square meter in the immediate area of the mining operation. However, at distances of 500 meters or more from the mining operation, peak values would be around 10 grams per square meter.

Visibility in the project area would decrease slightly as a result of the project. An increase in concentration from 25 to 42 ug/m^3 would produce a consequent decrease in ambient visibility from 35 to 27 miles. However, because the concentration impact would be very localized to the project area, this degradation is overstated. For lines of sight passing directly over the mining area and close to the ground, the impact will be in the range of 10 to 20 percent. For other vantages, the visibility degradation would be expected to be negligible. In particular, there would be no impact on visibility in the nearest Class I area, the Northern Cheyenne Indian Reservation. Another reason the impact is overstated is that the computation of visual range loss is based on particles of all sizes. Most visibility degradation occurs as a result of very small particles (less than one micrometer in size). Since less the ten percent of the Area C contribution can be attributed to these small particles, it is unlikely that any noticeable impact on visibility would occur.

E. NOISE

1. Construction Impacts

Among the first activities associated with the development of Area C, Block I would be the construction of shop and office facilitites and an overland conveyor from the mining area to the power generating station. This would require earth-moving and other construction equipment that would cause much higher than normal ambient sound levels in the construction vicinity.

The construction phases would generally include excavation, foundation work, erection, and finishing; the excavation phase would usually be the noisest. Typical sound levels produced by equipment used in the excavation phase are presented in Table III-11. A worst-case estimate of construction sound levels is derived by adding all the sources, weighted by the fraction of the work day the equipment is generally in operation. From Table III-4 the $L_{eq}(8)$ (i.e., the equivalent eight-hour sound level) at a distance of 50 feet from a point where all the equipment would be operating would be 92 dBA. However, because all the equipment would not be operating in the exact same location, this represents an upper limit to the construction noise level. Attenuation of this sound level due to distance alone would reduce construction noise levels to 72 dBA at a distance of 500 feet and to 52 dBA at 4,000 feet. The construction of the mine shops and offices would take place at a site more than seven miles from the townsite of Colstrip; due to distance attenuation alone, the $L_{eq}(8)$ construction noise would be reduced to 34 dBA, which would not be audible above to existing in-town sound levels.

2. Operation Impacts

During the operation of the proposed mine, heavy equipment would be used to remove the overburden and coal. Table III-12 lists the types and numbers of mining and reclamation equipment assumed to be in use at Area C. Overburden removal would probably occur full-time; coal removal would occur two shifts per day, five days per week. This equipment is likely to be in operation full-time during working hours. Field observations indicate that sound levels associated with existing overland conveyors are very low; because of these observations the conveyor noise was considered insignificant in comparison with other sources and was not included in the noise calculations.

Another source of noise due to mine operation would be blasting. Explosives are used in the removal of both overburden and coal. Unlike the continuous noise produced by mining equipment, blasting would occur intermittently and would be of very short duration. Approximately 136 overburden blasts and 320 coal blasts are expected each year. The noise produced by blasting depends on a number of variables, including the strength of the explosive charge and the amount of stemming placed behind the charge in the drill hole.

TABLE III-11

CONSTRUCTION EQUIPMENT NOISE PARAMETERS[a]

Equipment	Number	dBA @ 50'	Usage Factor
Air Compressor	2	81	1.00
Backhoe	1	85	0.16
Bulldozer	1	80	0.40
Generator	2	78	1.00
Jackhammer	1	88	0.10
Loader	1	79	0.40
Pump	2	76	1.00
Rock Drill	1	98	0.04
Shovel	1	82	0.40
Truck	1	91	0.40

[a] United States Environmental Protection Agency, 1971. Noise from construction equipment and operations, building equipment, and home appliances, NTID300.1

TABLE III-12

MAJOR NOISE SOURCES DURING MINING

Equipment Type	Number in Service	Noise Level at 50 Feet (dBA)
Out-of-Pit Equipment		
Dragline	1	75
Overburden Drill	1	90
Coal Hauler	3	89
Bulldozer	3	86
Front-end Loader	2	79
Scraper	4	87
Combined Noise Level		98.3 dBA[a]
In-Pit Equipment		
Coal-loading Shovel	1	79
Coal Drill	1	90
Coal Hauler	3	89
Bulldozer	3	86
Combined Noise Level		96.7 dBA[a]

[a]Logarithmic addition of each continuously operated equipment piece (i.e., usage factor of 1) at a distance of 50 feet from a point where all pieces are operating simultaneously.

Noise regulations designed to protect a community's exposure to ambient noise generally consider time-averaged noise levels. For example, EPA's guidelines use an equivalent sound level averaged over 24 hours. EPA also has a standard that adds a 10 dBA penalty to ambient sound levels measured between 10:00 p.m. and 7:00 a.m. to account for the additional annoyance during sleeping hours. Due to time-averaging, the infrequent and brief blasting noise has very little impact on average community noise levels. The continuous operation of heavy mining equipment would be more likely to affect average noise levels.

To provide a worst-case estimate of noise impacts due to the proposed mining activities at Area C, Block I, an approach similar to that used in estimating construction impacts can be used. Table III-12 lists the major sources of noise due to mine operation and typical sound levels associated with each at a distance of 50 feet. The equipment is subdivided into overburden and coal removal equipment since these take place at different locations. Bulldozers and coal haul trucks were evenly divided between the coal mining activities, which take place in the pit, and overburden removal, which takes place at the perimeter of the pit. Because this equipment is assumed to be co-located, even though in reality the pieces move all over the mine area, the estimate of the combined noise level is conservative.

The wide range in blasting noise levels is indicated in the measurements shown in Table III-13. These observations have been collected from several locations and include a variety of blasting conditions. The maximum sound levels indicated in the table are instantaeous measurements rather than time-averages.

The most important criterion that influences the impact of sound is distance from the source. Sound energy diverges or spreads out, and thereby results in lower sound pressure with increasing distance. This decrease or attenuation of the sound pressure level results in a decrease of 6 dBA each time the distance from the source is doubled; each time the distance increases by a factor of ten, the sound level decreases 20 dBA.

This attenuation due to distance alone would result in a substantial reduction in Area C, Block I noise by the time the sound reached Colstrip. Since the distance from the nearest part of Area C, Block I to the townsite of Colstrip is approximately 19,200 feet, the 98 dBA produced by the mine equipment would be reduced by distance alone approximately 52 dBA to about 46 dBA in town. The last column in Table III-10 shows blasting noise levels normalized to a distance of 19,200 feet.

Other factors also influence sound propagation through the atmosphere. These include the absorption of sound energy by the atmosphere, the refraction of sound waves due to temperature or wind speed gradients, and ground effects. Absorption of the sound energy by the atmosphere is highly variable and depends on relative humidity, the frequency of the sound, and to a lesser extent, on ambient temperature. Between Colstrip and Area C, sound absorption by air with a relative humidity of 20 percent could attenuate noise by 20 to 30 dB at 500 Hertz and 5 to 10 dB at 250 Hertz, but affects the lower frequencies very little.

TABLE III-13

MEASURED SOUND LEVELS DUE TO BLASTING[a]

Type of Blast	Distance to Blast (feet)	Measured Maximum Sound Level (dBA)	Approximate Sound Level at 19,200 feet (dBA)[b]
Coal	1,500	79.0	57
Coal	8,000	66.1	58
Coal	8,000	65.7	58
Coal	5,000	80.4	69
Coal	5,000	83.1	71
Coal	6,500	74.9	65
Coal	6,500	75.0	65
Coal	11,700	55.5	51
Coal	12,500	60.2	56
Coal	20,500	55.4	56
Coal	12,400	66.1	62
Coal	17,000	75.3	74
Coal	23,000	54.5	56
Overburden	8,000	86.2	79
Overburden	16,000	65.2	64
Overburden	16,000	67.8	66
Overburden	18,500	57.2	57
Overburden	24,900	57.0	59
Overburden	13,000	62.1	59
Overburden	21,400	55.1	56

[a]Source: Foch and Oliver, 1980

[b]Attenuation due to divergence only; atmospheric absorption and ground cover attenuation are not included.

The grass groundcover in the Colstrip area will also attenuate sound from the mining area. Over the distance from the mine to the townsite, this is enough to completely attenuate ground level sound transmission.

Atmospheric stability and winds also affect sound propagation. During stable atmospheric conditions, the temperature of the air and the speed of sound increase with height and cause sound waves radiating from a source to bend toward the ground. Similarly, winds that increase in speed with height reduce upward sound divergence and can cause higher sound levels at a downwind receptor than during calm periods. Either of these can lessen the attenuation of sound due to groundcover and topography by returning sound waves from above back to ground level.

In summary, it is unlikely that the operation of mining equipment would normally be heard in the community of Colstrip. Despite the potentially high sound levels at the mine, distance and other attenuation factors are expected to reduce sound to relatively low levels before it reaches Colstrip. Of equal important is the masking effect provided by the relatively high ambient sound level that currently exists in Colstrip due to the generating plant. Therefore, except under especially adverse meteorological conditions, mine noise is not expected to be discernible in Colstrip, and should certainly not have any effect in terms of hearing damage.

Depending upon the blasting techniques employed and upon meteorological conditions, blasting noise might be audible in Colstrip. Based on the measurements displayed in Table III-13, blasting noise would be not likely to cause hearing damage, but might be an occasional nuisance.

F. SOILS

Western Energy has proposed to replace approximately 27 inches of subsoil and 8 inches of topsoil, a total of 35 inches of replaced soil on the mined area of Area C, Block I. The soils resources of the remainder of Area C are less well defined at this time. The depths of replaced soils in Area C could be less than this in some areas. The soils at the Rosebud Mine in general present few serious limitations for reclamation. The major impacts in Block I that could be expected from mining and the proposed reclamation actions would be alteration of the physical and chemical character of the soils in the disturbed area. These alterations would not be anticipated to prevent revegetation or to seriously alter the character of surface water dynamics in the area; however, the changes would be sufficient to alter the soil moisture regimes and infiltration and runoff conditions, limiting potential plant communities and agricultural uses in the area. Within the proposed conveyor corridor, 95 acres of the 225 acres to be disturbed have previously been disturbed by mining activities. The soils on the remaining 131 acres along the route are relatively similar to the soils in Block I, Area C, and the impacts are anticipated to be similar to those identified for the Block I mining area. Recommendations for possible mitigation for the impacts discussed below are included in Chapter IV.

1. Biological Impacts

Two major soil handling methods would be used in Area C, Block I. In early phases of mining and for all areas to be disturbed by support activities, soil materials would be salvaged as subsoil and topsoil and stored. After the third mining pass, topsoil and subsoil layers would be hauled directly to a scarified, regraded overburden surface whenever possible.

In both methods, soil organic matter, microbial populations, and reproductive plant parts would be disturbed and mixed into the entire topsoil salvage layer, reducing the quality of the soils at the surface and the likelihood of growth from small seeds. In the cases where soil materials are stockpiled and stored, it is probable that populations of soil microorganisms would decline (Miller and Cameron, 1976). Reproductive plant parts such as bulbs, tubers, seeds, and roots might be attacked by an increased population of pathogens during storage, reducing their viability. This will reduce "volunteer" establishment of native forbs, shrubs, and grasses not included in the seed mix, and might suppress establishment of some plants included in the seed mixes due to continued high pathogen levels after stored soils were replaced (Miller, 1982).

After stored soils have been replaced on the regraded spoil, microbial populations can be anticipated to reach pre-mining levels in one to two years, for all groups of microbes except the blue-green algae, which have not yet been documented as being capable of reestablishment (Miller, 1982; Mott, 1982), based upon research on spoils up to ten years

old. In addition, for the microbial groups that would become reestablished, different microbial species would generally be involved, which allows for restoration of basic nutrient cycling functions within the soil but might not replace functions that are limited to a few species, such as soil aggregation (Miller, 1982).

Organic matter would oxidize and decompose during topsoil storage. The result would be a decrease in available nutrients, reduced water and nutrient-holding capacity of the soil, and a reduction in soil structure. From present research data, the time required to restore soil structure is uncertain. Soil organic matter and nutrients would begin to build up once vegetation is reestablished on the replaced soil, as dead plant roots and litter begin to build up in and on the soil and supply nutrients. It might take up to 20 years before vegetation requirements and nutrients available in the soil system reach a balance (Woodmansee et al., 1978).

2. Physical Impacts

Physical alteration of the soils would result from salvaging, handling, and replacing soils in the mine area and from changes in the underlying material or overburden. Soil moisture availability has a strong influence on the present and potential vegetation in the area. Changes in bulk density, infiltration and runoff characteristics, depth to rock or impermeable layers, and soil textural variations would alter existing soil moisture relationships and influence survival and dominance of vegetative types.

a. Bulk Density

Plant root penetration might be limited by high bulk densities in the subsoil or at the regraded overburden contact. Weakly consolidated sandstone in the Colstrip area has been shown to resist root penetration at a bulk density of 1.5 g/cm^3 (Schafer et al., 1979).

Most natural soils of the Colstrip area do not exceed 1.6 g/cm^3 (Schaefer et al., 1977). Measurements on regraded spoil and replaced soils at the Rosebud Mine and other mines show a wide range of bulk densities in which bulk densities in excess of 1.7 g/cm^3 are relatively common (Farmer and Richardson, 1976; Schaefer et al., 1977; Dollhopf et al., 1981; Stark, unpub. data).

As bulk densities become higher, infiltration by water is decreased and accordingly, more soluble salts may become concentrated nearer the surface than would occur in a freely draining system. Plant rooting depths would be decreased, increasing the competitive edge of the shallow-rooted cool-season grasses at the expense of deep-rooted warm-season grasses. Reduced water available for vegetation would result from decreased infiltration and increased runoff, which would also increase the potential for soil erosion. Most of these effects would not be seen until soil bulk densities exceed 1.5 g/cm^3.

Ponderosa pine communities, although they occupy a relatively small proportion of the area to be disturbed (11 percent) are important for wildlife, aesthetics, and for supplying vegetative diveristy. Work by Stark (1982) has shown that bulk densities of 1.3 g/cm^3 or less in near-surface soils are ideal for ponderosa pine survival and regeneration. Therefore, for areas that have been identified as areas to be reestablished to ponderosa pine, bulk densities of 1.3 g/cm^3 in the soils will help insure the survival and regeneration of the trees. Additionally, the trees may take advantage of free water available in much more dense rock material at depth in natural settings (see Chapter II, Section F), therefore areas where overburden bulk densities exceed 1.5 g/cm^3 areas may not be of concern.

The areas in which increased bulk densities are likely to occur are impossible to predict due to high variability in spoil placement and the moisture conditions of spoil and overburden when they are being handled.

b. Soil Textures

The tendency of soils to become compacted during placement is influenced by soil texture. Texture also influences infiltration, runoff, erodibility, and accordingly, soil moisture regimes.

Mining would result in the disruption of large, discrete areas of soils with similar textures that characterize the pre-mined environment, and would produce a landscape in which high horizontal and vertical variability in overburden, subsoil, and topsoil texture would occur. In general, this high variability would be expected to occur in small, random areas, with general homogenization of the soil types over the large area resulting.

Loamy soils, which presently occupy 44 percent of the disturbed land area, would make up an estimated 58 percent (by volume) of the soils placed on the post-mined land area. Sandy soils would decrease from 44 percent to 36 percent of the land area after mining. Clinker soils would decrease from eight percent to four percent after mining, and unbaked shale and siltstone soils would decrease from four to one percent.

Overburden textures tend, overall, to be moderate, however, relatively thick zones exist in topographically high positions with high sand content (greater than 70 percent) (see Geology, Technical Support Document). Also, some thin lenses of clayey textures with clay contents exceeding state suspect levels of 40 percent exist, however, these are generally isolated, thin strata. If the high sand content overburden material was to end up at the surface of the overburden without mixing, it could create a droughty condition for many plants, especially shrubs and trees. If clayey material was to end up on the overburden surface, it could restrict water movement and rooting depth, which could reduce the vigor of some species and increse the survival of other species with no easily generalized impact.

The alteration in soil types would decrease the overall water storage capability of the landscape by decreasing infiltration. Surface

erosion can be expected to increase, especially during the high-intensity rainstorms characteristic of the region.

Shallow-rooted, cool-season grasses could be anticipated to dominate the reclaimed plant community because of their higher adaptability to a wide variety of soil conditions. This would reduce the management options and potential diversity of grazing systems in the post-mined area, especially when compared to the pre-mining potential. Without special management or soil handling, ponderosa pine and skunkbush sumac plant communities may not be able to compete for limited soil moisture to form self-sustaining stands.

3. Chemical Impacts

Soils would be replaced on the reshaped landscape to an average depth of 2.8 feet. Accordingly, the lower part of the rooting profile would be composed of overburden. Presently, approximately half of the soils of Area C, Block I have low soluble salt contents (electrical conductivities of less than 1.0 mmhos/cm) within a five-foot profile, while other soils, especially loamy and clayey soils near drainages, have moderate to high salt contents (electrical conductivities of 6 to 20 mmhos/cm) in the lower portions of their profiles. On the reclaimed landscape, mixed, regraded overburden with moderate salt content can be expected to prevail. This would result in a moderation of the extremes of osmotic stress encountered by vegetation in the area. Shrubs such as sagebrush species and woody plants common to riparian areas, would encounter improved condition within their broad salt tolerance ranges; whereas some salt intolerant species, such as ponderosa pine or skunkbush sumac, may exhibit reduced growth or vigor due to the salt content of the overburden (Stark, 1982).

Although some degree of overburden mixing can generally be assumed, this does not preclude the possibility of unmixed material occurring near the surface in some areas. As indicated in studies by Dollhopf et al. (1981), the intensity of overburden sampling in Area C, Block I (average drill hole spacing 1,600 feet) can be used to predict the character of overburden with only 45 to 60 percent confidence, and gives even less indication of values that may occur at any horizontal or vertical location in the replaced overburden.

All that can be stated with confidence using the overburden data from Area C, Block 1 is that the trace elements exceeding state suspect levels found consistently in the overburden holes do occur in the area to be mined, with no conclusions possible as to their presence or absence in other, unsampled overburden. Trace elements not found in exceedance levels in the overburden sampling are not necessarily absent in the unsampled overburden.

Overburden commonly exceeds DSL suspect levels for nickel, molybdenum, and electrical conductivity. Cadmium and manganese exceedances occur in a limited number of samples. Zinc and lead exceedances have been linked to contamination by pipe joint grease and are unreliable.

Table III-14 shows the relationships of the 27 overburden holes in Area C, Block 1 to the exceedance values identified in sampling.

Although no predictions can be made regarding the location or distribution of exceedance values in replaced spoils, Dollhopf et al. (1981) found that if materials containing exceedances were five percent or less of the total overburden sampled, they were not detectable in the spoil pile. Thus, it is unlikely that cadmium or manganese would be found in the regraded overburden to an exceedance level. Material occupying 5 to 15 percent of the overburden could not be detected half of the time (such as electrical conductivity), and material with exceedance values that occurred more than 15 percent of the time in the overburden would always be found in the spoil pile, generally diluted to some extent from their pre-mine concentration. Therefore, the overburden properties most likely to be found in concentrations exceeding DSL suspect levels in the reclaimed spoils include soluble salts (electrical conductivity), nickel, and molybdenum.

Soluble salt level (electrical conductivity) is of concern in the rooting zone because it can increase moisture stress in plants. Ponderosa pine have been noted as being less vigorous and able to regenerate in soils with moderate to high soluble salts (Stark, 1982). In general, the soluble salt level in a majority of the existing subsoils is higher than the amounts that can be expected in the regraded overburden.

Nickel is of concern in the rooting zone because it may interfere with plant physiological functions, especially iron uptake (Torrey, 1978). This effect may not be apparent because of the 2.8 feet of topsoil in which most plants will have their roots, however if iron chlorosis does appear in the revegetated area, amelioration with supplemental fertilizers would be possible.

Molybdenum is of concern when it occurs in forage and is consumed by ruminants such as cattle and sheep. Little has been quantified about how much molydbenum, as measured by acid-ammonium oxalate extraction in the soil, will occur in forage. It is known that legumes tend to concentrate molybdenum, and that most of the high molybdenum forage found naturally occurs in poorly drained soils (Kubota, 1977). Molybdenum causes copper deficiency reactions if the forage in which it occurs makes up a significant part of an animal's annual diet (Hornick et al., 1977). If excessive amounts of molybdenum were to occur in the near-surface spoils, the limited cover of legumes to be established on the post-mine surface and the likely limited areal extent of such excessive concentrations would probably limit the percentage of molybdenum-rich forage. This would mean that a minor portion of a grazing animal's diet in the area would include these forage sources, and so molybdenum would likely not be a cause for concern. Due to the unpredictability of unsampled overburden and the many unknowns involved in the uptake process (Lindsay, 1979), the only way to quantify this impact would be to measure levels of molybdenum in forage growing on the reclaimed surface and compare that to molybdenum concentrations in the pre-mine vegetation, pre- and post-mine soils, and root zones.

TABLE III-14

OCCURRENCE OF LEVELS OF EXCEEDANCES IN OVERBURDEN

AREA C, BLOCK I

	Electrical Conductivity	Nickel	Molybdenum	Cadmium	Manganese
Number of Holes with Exceedances	12/27	19/27	21/27	4/27	—
Percentage of Sampled 5' Intervals Containing Exceedances	10%	30%	29%	4%	5%
Suspect Level	4-6 mmhos/cm	1.0 ppm	0.3 ppm	0.1-1.0 ppm	60 ppm
Exceedance Values:					
Mean	6.8 mmhos/cm	1.9 ppm	0.46 ppm	0.88 ppm	80.5 ppm
Range	4.03-11.4 mmhos/cm	1.01-7.6 ppm	0.3-3.6 ppm	0.1-3.9 ppm	61.4-124.0 ppm

4. Agricultural Potential

Although loamy soil acreage would be increased over the whole area, sandy and loamy soils would be placed indiscriminately on the landscape. Sandy soils would not be placed in drainages or on slopes exceeding ten percent, as required by DSL. Previous cropping success has been limited to large areas of loamy and clayey soils that could be managed in a similar fashion. Cropping success has been sporadic on sandy soils due to low water availability. The patchy intermingling of loamy and sandy soils on the post-mined landscape would reduce the potential for crop production.

5. Area C, Block II

In the life of mine area, Block II, the proportion of loamy and clayey alluvial soils is greater, compared to other soil types, than in Block I. This soil group has the highest potential for subsoil layers containing excessive soluble salts, which might limit salvage depths. There is a possibility, therefore, that the overall depth of soils suitable for replacement on regraded surfaces may be less than in Block I. The overall higher clay contents in the soils of Block II could also result in a greater tendency for compaction during replacement.

G. VEGETATION

Existing vegetation on approximately 1,627 acres of land in Area C, Block I would be destroyed, beginning with construction of facilitites and continuing as mining progresses. For all of Area C, the amount of vegetation destroyed would be about 7,900 acres.

Through reclamation procedures planned for Block I by Western Energy, vegetation would be restored to the entire disturbed area. The revegetation effort should result in plant communities consisting primarily of native species. The seed mixtures that Western Energy plans to use are made up of native plants (Appendix G, Table 2) with the exception of four species, cicer milkvetch (Astragalus cicer), sanfoin (Onobrychis viciaefolia), Kentucky bluegrass, and Canada bluegrass (Poa compressa). Woody species would be included in the seed mixtures, and in addition, trees and some shrubs would be planted as tubeling transplants. A tree spade would be used to transplant approximately 50 larger trees. Stocking rates for ponderosa pine (Pinus ponderosa) and Rocky Mountain juniper (Juniperus scopulorum) are to be equivalent to pre-mine conditions with an allowance for expected mortality.

The success of revegetation efforts takes several years to judge because of the many factors that enter into the dynamics of community establishment. Most of the revegetation efforts of sufficient age at the Rosebud Mine for analysis used mixtures of introduced and native and introduced species. In these areas, forage production has been almost double that of the pre-mine vegetation; however introduced cool-season grasses have dominated the community to the exclusion of many warm-season grasses, perennial forbs, or shrubs (DePuit et al., 1980). No areas have been completed using the two-phase seeding approach proposed for Area C, Block 1. One study area for native plant establishment techniques was established in 1977, and has shown positive results for both broadcast and drill seeding techniques and several levels of seed application and species mixes (DePuit et al., 1980). It is probable that a protective cover of vegetation can be established on the post-mine area with forage productivity higher than pre-mine levels. It is not certain whether all of the criteria for bond release, however, would be met, as this has yet to occur in Montana.

While overall success of the revegetation plan would be expected, post-mining vegetation would vary considerably from the pre-mining plant communities. These impacts are as follows:

- Rangeland forage production is likely to exceed pre-mining production as forage grass species become dominant providing weather is favorable and proper management is applied to the area. This would not happen immediately, but is expected to occur within five to ten years after final seeding, following an initial flourishing of annual grasses and weedy species.

- Increase in forage production should be in the range of 25 to 50 percent. This assumes that Western Energy would follow a deferred rotation grazing system and proper grazing use after

vegetation is well established and that root-inhibiting compacted layers are not created during overburden grading or soil replacement operations. (See discussion, Section F.)

- The amount of land in rangeland vegetation would be greater than in the pre-mining state because the disturbed hayland and pasture acreage would be revegetated with native species. Tame pasture and hayland would be reduced from 334 acres to 104 acres after mining. This would result in a reduction of about 250 tons of hay annually, and the loss of some early spring grazing. These losses would be partially offset by increased acreages of range for forage production.

- Post-mining sites would probably have less vegetative diversity than pre-mining sites, particularly on areas reclaimed with stockpiled soils. Lack of commercial seed sources for some species, particularly forbs, may prevent their initial establishment on reclaimed areas. Diversity should increase with age in the reclaimed area due to infilling from adjacent natural seed sources. The rate of increase in plant diversity by invasion from undisturbed plant communities will be a function of the reclaimed area's proximity to the undisturbed areas and the natural plant species propagule dispersal mechanisms, and the availability of suitable micro sites.

- The frequency of some of the grasses and shrubs species dominant before mining would be reduced under the proposed reclamation plan. This would be especially true for increaser species that had assumed dominant positions due to historical use patterns. The impact would be generally favorable in that the reduced occurrence of these species would more nearly reflect the potential climax community.

  Grasses - Prairie junegrass, found in pre-mining communities with frequencies of 30 to 70 percent, would be significantly reduced. This species is not included in any of the proposed seed mixes due to the unavailability of commercial seed, so its occurrence on the reclaimed surface would depend upon natural regenerative processes.

  Needle-and-thread grass occurs with a 70 percent frequency in the pre-mined grassland and skunkbush sumac communities. Seed for this species is included in the suplemental seed mix and so it is anticipated to be present in all reclaimed areas, but with a lesser frequency than in the pre-mined sites.

  Shrubs - The overall acreage of shrub cover will be reduced by about 33 percent. Within these acreages, it would be likely that the frequency of shrubs would be reduced to less than in the pre-mine shrub acreages because of increased competition from reseeded grasses. Table III-15 compares the acreage of pre-mine vegetative communities with acreage proposed for reestablishment in reclaimed areas. As the table shows, the major decrease in shrub species will occur in the

TABLE III-15

CHANGE IN VEGETATIVE COMMUNITIES
BEFORE AND AFTER MINING
AREA C, BLOCK I

General Vegetation Type	Acreage to be Disturbed	Post-Mining Acreage After Reclamation
Grassland	631 acres	1,345 acres
Big Sagebrush/Grassland	87	78
Silver Sagebrush/Grassland	77	19
Skunkbush Sumac/Grassland	72	60
Rubber Rabbitbrush/Grassland	4	2
Ponderosa Pine/Grassland	135	60
Cropland	376	60
Hayfield and Pasture	230	0
Areas Generally Devoid[a] of Vegetation	15	3

[a] In pre-mined areas this includes clinker pits, rock outcrops, and ranch yards. In post-mined areas this includes recreated sandstone "knobs."

silver sagebrush and skunkbush sumac types. All of the acreages presented in Table III-15 assume successful revegetation and do not include natural invasion of shrubs into post-mined areas. This is not meant to imply that invasion of shrub species may not occur, rather that it is not known to what degree this may happen.

- The area and distribution of ponderosa pine communities would be reduced: 180 acres of this vegetative type will be disturbed by mining, and only 60 acres are proposed to be planted with ponderosa pine. With complete revegetation success, only 55 percent of the disturbed ponderosa pine type would be replaced. To date, the establishment of conifers on scraper-hauled and regraded spoils at Colstrip has not been successful to the point that would indicate that stands of trees equivalent to pre-mine density could be established by the reclamation methods proposed by Western Energy. Researchers working at Colstrip (Richardson, 1981; Stark, 1980) have generally agreed that competition for soil moisture between trees and grass is the chief factor affecting survival of ponderosa pine seedlings and transplants, as well as other woody species. The reconstructed soils, due to their loamy and bulk densities, favor moisture uptake through the extensive shallow fibrous root systems of grasses, giving these plants the competitive advantage over the deeper root systems of woody species (see Soils, Section F).

- Discrete range sites presently existing in Area C, Block I would not be restored in the reclamation process due to mixing of soils. This would constitute the loss of potential for separate and distinct plant communities inherent in the existing range sites, and the spatial, seasonal, and species diversity presently found in the area.

Western Energy has not submitted specific reclamation plans beyond Block I for Area C but, it is assumed that revegetation efforts would be subject to similar influencing factors described in Block I. Future reclamation plans would incorporate results from revegetation experience and studies on earlier reclaimed mined areas. Post-mining revegetation conditions would probably approximate Block I, but would reflect the specific reclamation plans and climatic and soils conditions under which the plans are implemented (see Sections F and G, Chapter III).

H. WILDLIFE

In general, the significant areas of concern for impacts pertain to disturbance to especially valuable habitats or features. Most notably, these include: the prominent sandstone outcrops/cliffs that have historically served as nesting habitat for several raptor species, including the golden eagle and prairie falcon; the wooded and shrubland habitats, which provide nesting sites, and forage and shelter; and perennial and seasonal sources of surface water available to wildlife. Two specific sites of special concern exist in Area C, Block I: a golden eagle nest site and a sharp-tailed grouse dancing ground. The U.S. Fish and Wildlife Service has recommended that the sandstone outcrop on which the golden eagle and prairie falcon nests are located not be destroyed (U.S.F.W.S., 1981). Also, DSL has requested a 100-meter buffer zone be left between the outcrop and the mine. Western Energy is continuing its sponsorship of mitigation investigations on sharp-tailed grouse, particularly dancing ground reestablishment. The anticipated mining pattern for the Area C, Block II life of mine would eliminate the sandstone cliff nesting sites as well as two sharp-tailed grouse dancing grounds. These nesting sites and dancing grounds may have regional importance to the raptor and sharp tail grouse populations.

Legal and illegal hunting, wildlife vehicle collision mortality, and other human-wildlife interactions could be expected to increase with new and expanded development. Thus, a somewhat greater disturbance from human presence, including vehicle collisions with wildlife, could be expected in the immediate Area C vicinity as mining begins. No impacts to wildlife are expected as a result of the location and operation of the conveyor. Except for one mile, the conveyor corridor is located in areas already disturbed by mining.

Nearly all of the area to be disturbed by the Area C mining operation currently serves as habitat for a variety of wildlife. The reclamation plan would alter the proportions and composition of habitat types somewhat. Some of these changes would be neutral to beneficial if realized, but others, especially the reduction of ponderosa pine and shrublands by more than 50 percent, would represent long-term negative change. A reduction in the overall diversity of available habitats can generally be expected to be reflected in reduced wildlife diversity. Pre- and post- mining vegetation types are compared in Section G, Vegetation. The following sections discuss the noteworthy mining impacts to wildlife groups in the vicinity of Area C.

1. Big Game

During the years of active mining, active mine areas would be less suitable for big game. However, the relatively low big game populations in the area in recent years and availability of alternative habitat in adjacent, undisturbed areas suggest that this impact may not be a significant limiting factor.

Because of the importance of ponderosa pine and shrub habitats to mule deer, the unknown efficacy of efforts to reestablish these habitats

after mining, and the proposed reduction of the ponderosa pine type on the area, suitability of the area for mule deer use is expected to be somewhat decreased by the proposed action. Reduction of sagebrush-grassland may make the area less suitable as pronghorn habitat.

Finally, habitat surrounding Area C is comparable to Area C, and may serve as alternative habitat. No evidence is available suggesting that deer or antelope populations in the area are presently limited by available habitat or food sources, so Area C does not appear to be critical to the welfare of deer and pronghorn in the study area.

2. Other Mammals

Although Area C mining activities would temporarily eliminate small mammal populations in the disturbed area, there is no indication that any especially sensitive species of small mammals would be affected by the mining operations. To the extent that the general small mammal population is important as a prey base for raptors, this prey base would be reduced until a diverse, stable vegetative community, adequate to support the kinds and numbers of small mammals present now, is re-established. Limited studies in various Colstrip area habitats, including reclamation sites, suggest that small mammal populations may be larger, though less diverse, at least in the early years of reclamation. However, the alteration of the proportions of various habitats could affect the relative attractiveness of the area to the different small mammal species. This is particularly true of species such as porcupine and chipmunks, which are associated with wooded and shrubby habitats; and rabbits and marmots, associated with rocky microhabitats.

3. Mammalian Predators

Mining in Area C, Block I would temporarily render disturbed areas unsuitable for mammalian predators because of the lack of prey and proximity to human activity. It is not certain how successful the plans for revegetation will be in supporting a prey base similar in numbers and diversity to that now on the site. Therefore, it is not known which predators will return to the area.

The coyote is the most common mammalian predator in the area, but since the coyote doesn't appear to be habitat- or food-limited in the area, the habitat loss asociated with disturbance of Area C development should not significantly affect local coyote populations.

4. Upland Game Birds

One sharp-tailed grouse dancing ground may be disturbed by haul road construction and use. Feeding and nesting habitat near this dancing ground would also be reduced. It is uncertain what effect the reduction in feeding and nesting habitat and the disturbance to the dancing ground will have on sharp-tailed grouse in this local area. Western Energy will attempt to replace the dancing ground in Area C if it is abandoned during the mining operations.

Other upland game birds, such as ring-necked pheasant, Hungarian partridge, Merriams' turkey, and sage grouse are infrequent in Area C and are thus not likely to be significantly affected by the Area C mining operation.

5. Waterfowl

Waterfowl nesting and feeding habitat in Area C would be reduced during active mining. Reclaimed areas should replace this loss. Mining would not be expected to have appreciable impact on waterfowl species.

6. Songbirds

The revegetation program would alter the relative proportions of songbird habitats in the disturbed area. A reduction of shrub and woodland bird species would be expected. For example the impact to cavity-nesters would be long-term.

7. Raptors

One golden eagle nest, which was active in 1978, has been documented in Area C. Golden eagles are regularly sighted, especially in the spring, in and near Area C (ECON, 1975, 1976, 1977, 1978, 1979; Western Energy, 1980). Eagles are protected by the Bald Eagle Protection Act of 1940 as amended in 1962 (16 USC 668a), which prohibits "taking" of eagles or their nests, active or inactive. "Take" is further defined as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, or molest or disturb" (16 USC 668a). The Block I mining plan does not propose to physically disturb the nest site itself. The U.S. Fish and Wildlife Service has not yet determined whether or not the proximity of proposed mining activities to the nest site would constitute a disturbance within the definition of the law.

No specific studies have been conducted on hunting territories and food habitats of the golden eagles in the Colstrip area. Studies by Tyus and Lockhart (1979) suggested that breeding territories range from about 10 to over 20 square miles. Important food sources for golden eagles include rabbits, marmots, grouse and other species. Sharp-tailed grouse radio-tracking studies in the Colstrip area suggested that golden eagles may be a significant grouse predator in the area (ECON, 1966, 1976).

In addition to the possible reduction of hunting territory, the more direct threat of nest abandonment from direct disturbance exists. The sensitivity of raptors to disturbance varies tremendously between species and between individual pairs of the same species. Golden eagles and prairie falcons are both considered sensitive to human disturbance (Call, 1978).

Block I mining would also destroy some nesting and hunting habitat for other raptors, including a localized long-term reduction in mature ponderosa pine nest sites. Several of the raptors observed in Area C are of both state and federal concern (Flath, 1981; Spear, 1980). Although present evidence is not adequate to assure revegetation would produce a raptor prey base comparable to present conditions, the area disturbed by Block I mining would be relatively small compared to the normal hunting range of most raptors in the area. It is not known whether a displacement of hunting territory out of the mine area will affect nest success.

8. Reptiles and Amphibians

Few reptiles and amphibians would be affected by mining in Area C. Hognose snakes (Heterodon sp.), of special concern in Montana (Flath, 1981), may be present, but this is not certain, as no special reptile surveys have been conducted. Rattlesnakes and other predatory reptiles would return to the area as reclamation progressed and prey populations began to recover in revegetated areas. Microhabitat changes, particularly reduced availability of rock habitats and winter denning areas after mining, may inhibit repopulation of reptiles.

9. Threatened and Endangered Species

No threatened or endangered species have been identified for Area C, Block I. If threatened or endangered species are found in or adjacent to Area C, consultation with the U.S. Fish and Wildlife Service would be undertaken and mitigation taken as necessary in compliance with the Endangered Species Act.

I. SOCIOLOGY AND ECONOMICS

1. Economic Condition

a. Employment and Population

Annual impact employment projections for Rosebud County and Colstrip are presented in Table 19 (Appendix I). Similar quarterly data is exhibited in Table 20 (Appendix I). As indicated by these tables, the impact employment in Rosebud County and Colstrip associated with the Area C work force addition peaks during the second quarter of 1983. However, when this additional work force is added to the baseline forecast, shown in Tables 10 and 11 (Appendix I), total employment in Rosebud County and Colstrip peaks the fourth quarter of 1982. Annual baseline and impact employment peaks in 1983 at 8,168 in Rosebud County. Projected county employment declines to 5,940 in 1985, stabilizing through 1995, and then rises to 6,596 in 2010. Area C increases the baseline county employment projections by 4.8 percent in 1983, 6.0 percent in 1990, and 5.8 percent in 2000.

In comparing 1982 and 1983 annual and quarterly peaks, it is important to note the differences between quarterly peaks and annual peaks. Annual data indicate that the peak baseline and impact population occurs in 1983 rather than 1982. When analyzed quarterly, peak baseline plus impact employment and population occurs during the fourth quarter of 1982, stabilizes through the second quarter of 1983, and then declines sharply during the third quarter of 1983. Although dependent on current construction schedules and nonlogged responses, the available data indicates that peak populations will begin during the last half of 1982 and extend through the first half of 1983.

The Area C addition is expected to result in about 210 new basic jobs between 1985 and 2010. These new jobs are projected to result in about 130 nonbasic, or derivative jobs for a total employment gain in Rosebud County of about 340 positions, or approximately six percent of projected baseline employment. The employment (basic/nonbasic) multiplier for the impact scenario is about 0.6, lower than that projected for the baseline conditions. This is because the basic impact employment includes nonlocal miners and construction workers and government services were not expected to expand much as a result of the Area C expansion.

The impacts of permanent mining and temporary heavy construction employment were treated separately in this analysis. Temporary heavy construction employment related to the proposed mining activities in Area C, Block I was assumed to have no effect on derivative employment in Rosebud County. The existing work force in trade and services was assumed to assimilate the additional temporary impact. Mining employment, on the other hand, was assumed to have an effect on support sector employment. Retail and service employers in the area were assumed to regard mining employment as long-term and to expand or build new facilities to accommodate the enlarged economic base.

Colstrip's annual impact and baseline population is expected to peak in 1983 at 7,259 persons. This figure, when compared with the 1982 fourth quarter peak of 8,205, emphasizes the importance of quarterly analysis. Annual peak 1983 employment and population for Rosebud County, including both baseline and impact forecasts, are 8,168 and 16,419 persons, respectively compared to the 1982 fourth quarter peak figures of 8,770 and 17,570 persons.

Population impacts for the temporary heavy construction work force in Area C, Block I were also assumed to be different from those for the more permanent mining work force. The projected impact work forces were residency-adjusted before the population impacts were computed to account for out-of-Rosebud County and out-of-Colstrip commuting. It was assumed that 30 percent of the construction work force and 37 percent of the mining work force would commute into Colstrip. Ten percent of the mining work force and 15 percent of the construction work force were assumed to commute into Rosebud County (Edwards, Reardon, Spiegel, Tomasik, 1982).

Population projections for Rosebud County and Colstrip are shown in Tables 19, 20, and 21 (Appendix I). Baseline and impact projections parallel those for employment, mentioned above. Rosebud County population is projected to peak during the fourth quarter of 1982 at 17,570. Annual population is expected to peak at 16,415 during 1983. It is projected to decline to 12,191 in 1985, and stabilize through the year 2000. Area C expansion will add between 5.5 and 5.8 percent to the projected county baseline population after 1985.

The population of Colstrip would be expected to peak at 8,205 residents the fourth quarter of 1982. About 60 percent of these residents would be temporary. Of the peak 1982 population, approximately 540 (about seven percent) would be attributable to the Area C expansion. The Colstrip population would remain at a relatively high level (8,096 residents) until the second quarter of 1983, when it would begin to decline. The maximum population attributable to Area C would occur at this time and would comprise about 816 persons (about ten percent of the total population). The latter population contribution would occur as the construction crews for generating Units 3 and 4 are declining and would slightly reduce the rate and prolong the period of population decline in Colstrip. The Area C operations would contribute approximately 250 permanent residents to the Colstrip population by late 1983. The total population of Colstrip is expected to stabilize at about 3,700 residents by 1985 or 1986, when all planned construction has ceased. At this time, the population attributable to the proposed operations at Area C, Block I would be about 12 percent of the total resident population.

b. Personal Income

Table 22 (Appendix I) presents mining and construction income, Montana personal income tax payments, and the Area C, Block I, work force for the forecast period 1982 to 2018. Total labor and proprietors' income in Rosebud County would increase as a result of the Area C expansion. In 1980 dollars, Area C would increase Rosebud County labor and

proprietors' earnings from a low of about 2.6 percent in 1982 to a high of about 11.2 percent in 2010. The continued industrialization of Rosebud County is not expected to significantly increase labor costs to local businesses. Also, the 1970-1979 trend in wages is consistent with local persons filling many of the new jobs (Polzin, 1981).

2. Social Life

The social impact of the population increase attributable to the Area C, Block I mine operations would be small in the context of the sizes of the total and transient populations induced by all development in Colstrip. Additional burdens would be placed upon some already overextended social and community service programs (e.g., formal recreation programs, shopping); these additional burdens will reduce the availability of such services and reduce the quality of social life to some unmeasured degree. The proposed project also would slightly prolong the period in which transient residents comprise a significant proportion of Colstrip's population. According to area informants, the presence of large numbers of transients within the Colstrip population inhibits the development of a community identity. The persons brought to Colstrip by the proposed project would be very similar to the present residents of Colstrip. As such, they are likely to share similar values, patterns of social interaction, and recreational habits. Their occupations and pay scales would also be identical to those of many present residents of Colstrip. Given this similarity, the impact of the proposed project upon the social life of Colstrip is expected to be minimal. The determination of minimal impact is based upon the similarity of newcomers and with consideration of the context of existing social life in Colstrip. That context is of an unstable social life for many, with relatively few of the social amenities many people have come to expect, a large proportion of people considered to be (and who consider themselves to be) transient, and widespread feelings of powerlessness, rootlessness and anonymity.

3. Social and Community Services

a. Law Enforcement

The Rosebud County Sheriff has indicated that anticipated population growth induced by the construction of Colstrip Units 3 and 4 and the Area C, Block I mine might require the addition of one deputy and one secretary to his Colstrip staff (Ash, 1982).

b. Fire Protection

The additional Colstrip population attributable to the proposed project would not be expected to have a significant impact upon the provision of fire protection services.

c. Sanitary Sewer

The additional Colstrip population attributable to the proposed project would not be expected to have a significant impact upon the local sanitary sewer system.

d. Water Supply

The additional Colstrip population attributable to the proposed project would not be expected to have a significant impact upon the local public water supply.

e. Solid Waste

The solid waste load is projected to increase about seven percent as a result of Area C. Solid waste collection capacity in Colstrip is adequate to serve projected peak populations. The capacity of the area waste disposal site is adequate for present and projected populations.

f. Social Welfare

The increase in population attributable to the proposed project would not be expected to have a significant effect on the provision of social welfare services in Colstrip.

g. Medical Services

Existing medical services and resources are inadequate to meet the present Colstrip residents' needs as well as the added population brought in by the proposed project according to the Montana Health Systems Agency. Mental health services are considered to be overextended at present; therefore, additional population growth would further aggravate this situation. Many rural communities in Montana also are similarly underserved and are apt to remain so because of their small populations and distance from major medical facilities. No specific estimates of the type of medical or other health manpower are available for Colstrip's projected peak populations. The difficulty of recruiting health manpower and the expense of health/medical facilities make it unlikely that the problem will be resolved in the near future, and certainly within the projected peak population period.

h. Housing

Table 23 (Appendix I) contains projections of housing demand in Colstrip as a result of the proposed project. The proposed project would create a 12 to 14 percent increase in Colstrip housing demand through 2010. Although the maximum housing demand of 295 units would be projected to occur in the third quarter of 1983, when reviewed in combination with the baseline projections, the maximum total housing demand of 2,943 units would be projected to occur in the fourth quarter of 1982. Peak housing demand would be projected to exceed the proposed housing unit supply by 60 units. This would not be considered problematic because of the possibility that more "doubling up" may take place

than is anticipated, or the schedule may lag, causing the projected fourth quarter housing impact to be delayed until early 1983, when the baseline housing demand would be smaller.

i. Education

Table 24 (Appendix I) shows the current and projected elementary (kindergarten through eighth grade) and high school (grades nine through twelve) enrollment in Colstrip School District #19 by year through 1985 and in five-year intervals thereafter to the year 2000. The increase in enrollment attributable to the proposed project is also identified in the table. During the next two years, elementary and high school student enrollment would be expected to increase substantially, with the addition of 496 new elementary and 192 high school pupils, primarily due to the anticipated increase in the size of the Colstrip Units 3 and 4 work force. Thereafter, school enrollment would decline and then stabilize in 1985; with a total of approximately 1,100 students, of whom about 30 percent will be in high school and the remainder in grades kindergarten through eight.

The increase in enrollment attributable to the proposed project would be small. Starting in 1982 with 56 students, the enrollment increment would increase to 143 students by 1985 and then stabilize at that general level thereafter.

With the completion of the new Pine Butte Elementary School by September 1982, the Colstrip school district would have sufficient capacity to educate all students attrbutable to Area C expansion and projected to reside in the area. Through 1984, there will be a continuing need for the modular, wood-frame classrooms that currently serve as the Pine Butte School. Thereafter, the new Pine Butte and Isabelle Bill Schools would have sufficient capacity for all elementary students. Also, the current high school facility can accommodate the projected enrollment increase. Given the small size of the existing high school classes there appears to be little need to add teaching staff at the high school level. Additional space for secondary students would be available in the fall of 1983 with the completion of the proposed new Colstrip High School.

4. Public Finance

The proposed project would add significantly to the taxable value for the county and both school districts.

The forecasted impacts of the proposed project on the fiscal condition of Rosebud County are presented in Table 25 (Appendix I). It should be noted that property taxes on non-Area C, Block I property are expected to decrease as the total taxable value of the county is increased by the Area C, Block I coal production and ancillary equipment. The net effect on taxable value in the county due to the two primary taxable components of the mine expansion, capital investment and gross proceeds,

is shown in Table 26 (Appendix I). The peak increase in taxable value due to Area C occurs in 1990. However, Table 27 (Appendix I) indicates that Area C constitutes an increasingly greater percentage of county taxable value through 2015 as the baseline taxable value diminishes. The increase in a given year in total taxable value under the balanced budget scenario forces mill levies down below those projected under the baseline scenario.

The net effects of the Area C expansion on Rosebud County local revenues and operating expenditures are shown in Table 28, Appendix I. At most the proposed expansion would result in an increase of approximately six percent in either operating expenditures or local revenues.

The projected impacts on the two school districts are shown in Tables 29 and 30 (Appendix I). Revenue and expenditure patterns similar to those occurring in the baseline projections are expected. However, revenues and expenditures are somewhat higher for the reasons discussed above. Mill levies in the balanced budget scenarios are somewhat lower, due to the effects of the Area C expansion on taxable value in the school districts.

The forecasted impacts of the proposed project on the Colstrip townsite finances are presented in Table 31, Appendix I. The net effects of the Area C expansion on local revenues and operating expenditures in the Colstrip townsite, as presented in Table 32 indicate that at most the proposed expansion would result in an increase of approximately 13 percent in either local revenues or operating expenditures. The influx of workers into the townsite would not be expected to significantly affect the level of services required, or the overall fiscal condition.

In addition to creating additional revenues for the local taxing jurisdictions, the Area C expansion would result in the payment of approximately $189 million (1980 dollars) in federal royalties, roughly half of which would be returned to the state, and payment of approximately $318 million in Montana coal severance taxes (Table 33, Appendix I).

J. LAND USE

1. Direct Impacts

The major direct impact on land use in Area C, Block I would be the addition of 1,627 acres of mining disturbance at the Rosebud Mine, which represents an increase of about 59 percent over the current disturbance at the Rosebud Mine complex. The change in land use patterns in Area C, Block I is presented in Table III-16.

Livestock grazing would be precluded on 1,006 acres (less than 0.04 percent of available rangeland in Rosebud County) during active mining and intial reclamation. After vegetation is reestablished (about three years after seeding, providing natural conditions warrant), limited grazing under the planned pattern can begin (see Section G, Vegetation). The planned deferred grazing pattern would continue until bond release (a minimum of ten years), after which normal ranching operations could resume.

Vegetative productivity would fluctuate during intial vegetation establishment due to such factors as early rapid growth from seeding operations and subsequent natural changes in species composition as the vegetative cover stablizes. Actual post-mining productivity under proper management would probably be higher than pre-mining levels (see Vegetation, Section G).

The amount of cropland that would be displaced by the proposed plan (about 606 acres) amounts to about 0.5 percent of the total cropland in Rosebud County. Since the cropland in Area C, Block I would be reclaimed as rangeland, (with the exception of about 60 acres disturbed by facilities, topsoil stockpiles, and haul roads that would be returned to cropland), this acreage would be unavailable for use as cropland until after bond release, at which time surface owners could put the reclaimed land to other uses. The suitability of irrigating cropland in the vicinity of Area C, namely along Stocker Creek and East Fork Armells Creek, could be diminished by mining activities if water quality were adversely affected (see Section B, Hydrology). This could affect about 1,825 acres of land in Area C that is potentially irrigable (Hydrometrics, 1981), although most of this acreage is not irrigated at present due to insufficient flow during the majority of years.

All projected mining and power generation in Rosebud County would displace livestock grazing on about 24,000 acres (less than one percent of the available grazing land in Rosebud County (Montana Department of State Lands, 1981). Mining activity in Area C, Block I would contribute to less than four percent of the total displacement. Similarly, the total projected acreage of consumed cropland due to mining and power generation in Rosebud County is about 800 acres (0.6 percent of the available cropland in Rosebud County) (Montana Department of State Lands, 1980). Mining activity in Area C, Block I would contribute to about 75 percent of the total consumption.

TABLE III-16

SUMMARY OF LAND USE IMPACTS
IN AREA C, BLOCK I

Land Use Category	Present Use	Use During Active Mining (1982-1987)	Post-Mining Land Use (After Reclamation)
Rangeland			
Grassland and Shrubland	1,724	853[a]	2,360
Ponderosa Pine	180	45	105
Cropland			
Grain Fields	436	60[a]	120
Hay Fields	334	104[a]	104
Mining Disturbance	0	709	0
Mine Facilities and Associated Disturbance	0	918	0
Other Land (Sandstone outcrops, clinker pits, and abandoned ranch yard)	19	4	4
	2,693 acres	2,693 acres	2,693 acres

Most of the county-wide displacement of rangeland would be temporary, except for about 890 acres that would be permanently converted to urban and industrial uses (Montana Department of State Lands, 1981). The proposed project in Area C, Block I would not be expected to contribute significantly to the increased urban and industrial land use, the bulk of which is due to the construction and operation of Colstrip generating Units 3 and 4.

Long-range changes in land use could occur with additional mining activity subsequent to the development of Area C, Block I. (See Sections F, G, and H, Chapter III.)

The conveyor corridor would cut through the cropped lands located inside the Area A loadout facility railroad loop. Approximately 70 acres are currently irrigated and produce approximately 2.0 tons of hay per acre annually. The corridor would occupy only 6.5 acres, but could prclude the irrigation on all or a portion of the remaining 63.5 acres for the life of the conveyor facility.

2. Indirect Impacts

The Colstrip Townsite Expansion Master Plan calls for increased housing, facilities, streets, and parks to meet the demands of power plant construction (Units 3 and 4) and coal mine expansion (Rosebud County Planning Board, 1980). This land use plan is expected to adequately incorporate population increases that could result from the development of Area C (see Section I, Sociology and Economics).

No adverse impacts are anticipated to federal planning as it pertains to the BLM's management Framework Plan.

K. TRANSPORATION

Development of Area C would bring in a maximum of about 302 workers during the construction phase, and a maximum of about 228 workers during the operation phase (see Section I, Sociology and Economics). Of these workers, approximately 30 percent would be expected to live outside Colstrip and commute into the area. During the construction phase, approximately 100 workers would be commuting into Colstrip, with about 40 workers living outside Rosebud County. Assuming that 50 percent of the workers would car pool, and 25 percent of those workers living in Billings or Miles City would use commercial bus service to Colstrip, the resulting traffic increase would be about 65 additional vehicles per day using FAP 37 and/or FAP 39 (or 33 additional vehicles along any given segment) distributed over three shift changes (Table III-17). Similarly, estimated traffic increase during the operation phase would be about 57 vehicles per day (or 28 additional vehicles along any given segment). These increases are less than five percent of current daily traffic levels, and should not have any significant impact, particularly with the completion of the proposed highway reconstruction (Rice, 1982). With the completion of Colstrip generating Units 3 and 4, traffic levels should decrease substantially.

Rail capacity would not be affected because all coal recovered in Area C would be transported to the Colstrip generating units by conveyor. The coal conveyor would undercross the county road, thereby causing no traffic interference.

The proposed plan would necessitate the permanent relocation of about four miles of the East Fork Castle Rock County Road (R140) to about 0.5 mile north of its present location, and about two miles of the East Fork Armells Creek County Road (R141) to about 0.50 mile south of its present location (Figure II-22). In their present location, these roads would be disrupted by mining activities. The Rosebud County Commissioners in Forsyth have determined that the proposed relocation would not adversely affect the public or the surrounding land owners (letter of November 13, 1981 to Western Energy Company). During mining years 21 through 34, County Road 141 would have to be relocated or closed because the road would be displaced by mining. The rebuilt road would comply with the standards set forth by the county commissioners in their letter of November 13, 1981.

TABLE III-17

POTENTIAL INCREASED DAILY TRAFFIC LEVELS

	Construction Phase (1982-83)		Operation Phase (1984-2010)	
	Workers	Vehicles[d]	Workers	Vehicles[d]
Living in Colstrip[a]	202	--	144	--
Communting Solo	40	40	36	36
Car Pooling[b]	50	25	42	21
Commercial Bus Service[c]	10	--	6	--
	302	65	228	57

[a] Assumes that workers living in Colstrip would not be commuting along major highways and may use Western Energy Company's shuttle bus service to the mine.

[b] Assumes 50 percent of commuting workers would carpool in groups of two.

[c] Assumes 25 percent of workers commuting from outside of Rosebud County would use commercial bus lines from Billings or Miles City.

[d] This represents total additional commuting vehicles. If half commute via northern routes to Colstrip and half via southern routes, increased vehicular traffic along any given segment would only be 50 percent of the represented number.

L. RECREATION

1. Urban Recreational Resources

All Colstrip Area Recreation and Parks Association (CARPA) recreational resources and facilities are used to capacity at present population levels and are considered inadequate to serve the existing population (see Chapter II, Section I). To date, CARPA reportedly has been unable to use school facilities for recreational purposes, due to scheduling conflicts. Colstrip is in need of additional multi-purpose recreation space, indoors and outdoors. The existing needs for space will not be met, even with the completion of the Stillwater Park in the fall of 1982 (Noyd, 1982). The project would sustain these use pressures by maintaining high population for an extended period; however, the long-term recreational needs would decline in direct proportion to the 45 percent decline in projected population between 1982 and 1983 with the completion of Units 3 and 4.

2. Impact on Nonurban Recreational Resources

Additional population growth attributable to the proposed Area C, Block I mine operation would impose no significant negative impact to the area's nonurban recreation resources.

M. CULTURAL RESOURCES

1. Area C, Block I

A summary of project impact to the nine cultural resources in Area C, Block I is presented in Table III-18. The mining would partially or totally destroy seven of these sites: Lynn's Square, Gene's Vision Quest, Cooley Site, Fadhl Kill Site, Fadhl Homestead, Tripoint, and Medicine Root sites. The Three Ring and the Farley Lookout sites are located adjacent to the mining areas and may be affected by erosion, vandalism, or off-road vehicle use.

Of the seven sites that would be destroyed, three (Lynn's Square, Gene's Vision Quest, and the Tripoint Sites) appear to be ineligible; and three (the Cooley, Fadhl Kill, and Fadhl Homestead Sites) appear to be eligible for nomination to the National Register of Historic Places. One site (the Medicine Root Site) needs additional testing before a National Register recommendation can be made. Of the two sites located adjacent to direct mining or construction activity areas, one (the Farley Lookout Site) appears to be eligible for nomination to the National Register. The other (the Three Ring Site) does not.

Mitigation, in the form of intensive data collection and recording or other approved methods, is required prior to the disturbance of those sites determined eligible for the National Register. Those sites determined ineligible have been fully recorded and the information placed on file.

2. One-Mile Buffer Zone

The purpose of the buffer zone survey was to locate and identify cultural resources that could be affected by blasting. Most prehistoric sites would not be affected with the exception of rock and rock shelters. Likewise, only historic sites with standing structures would be affected. However, all sites in the buffer zone may sustain increased deterioration through vandalism.

A summary of project impact to the 25 sites within the one-mile buffer zone around Area C, Block I is presented in Table III-19. Eleven of the 25 cultural resources have rock art or standing structures and could be affected by blasting. Of these, three (Doc Taylor Place, Muskrat Homestead, and Cooley Place sites) appear to be eligible for the National Register; seven appear ineligible for the National Register (Dusty Shelter, Castle Rock Post Office and Homestead, Caskey 310, Lovelace Memorial, Petro City, P.E. Davis Rock Art, and Connie's Gallery); and one (Forsite) needs testing before a National Register recommendation can be made.

The Sly Bison and Insite sites, identified in Chapter II as potentially eligible, are prehistoric and neither contains rock art or standing structures. Thus, they would not be affected by blasting. Similarly, the East Fork and Albino Deer sites and MAL 1401, which need testing would not be affected.

TABLE III-18

SUMMARY OF IMPACT TO CULTURAL RESOURCES
AREA C, BLOCK I

National Register Eligibility	Impact Assessment
Sites Considered Ineligible	
1. Three Ring Site (24 RB 1060)	1. Site may be impacted. Site is located between the boxcut and spoils reduction area, a road construction area, and a scoria pit. Impact assessment unnecessary if site is ineligible for National Register.
2. Lynn's Square (24 RB 1071)	2. Site would be destroyed. It is located within the highwall reduction area. Impact assessment unnecessary if site is ineligible for National Register.
3. Gene's Vision Quest (24 RB 1072)	3. Site would be destroyed. It is located partially within a topsoil stockpile area Impact assessment unnecessary if site is ineligible for National Register.
4. Tripoint Site (24 RB 873)	4. Site would be destroyed. It is located within the mining pit area. Impact assessment unnecessary if site is ineligible for National Register.
Sites Considered Eligible	
5. Cooley Site (24 RB 1059)	5. Site would be at least partially destroyed. The northern portion of the site is located within a road construction area, and a pit power feeder transmission line passes through the center of the site. Impact would be considered significant if site is determined eligible for National Register.

TABLE III-18 (Continued)

National Register Eligibility	Impact Assessment
6. Fadhl Kill Site (24 RB 299)	6. Site would be destroyed. It is located within a boxcut spoils reduction and road construction area. Impact would be considered significant if site is determined eligible for National Register.
7. Farley Lookout Site (24 RB 1058)	7. Site may be impacted. It is located adjacent to the highwall reduction area. Impact would be considered significant if site is determined eligible for National Register.
8. Fadhl Homestead Site (24 RB 884)	8. Site would be destroyed. It is located within the mining pit area and a road construction area. Impact would be considered significant if site is determined
Sites Requiring Additional Work Before National Register Recommendation Can be Made	
9. Medicine Root Site (24 RB 879)	9. Site would be destroyed. It is located within the highwall reduction area. Impact assessment cannot be made without eligibility recommendations.

TABLE III-19

SUMMARY OF IMPACT TO CULTURAL RESOURCES

BUFFER ZONE

Sites	National Register Eligibility
Potential Impact from Blasting and Vandalism:	
1. Doc Taylor's Place Site (24 RB 1065)	Appears eligible.
2. Muskrat Homestead Site (24 RB 313)	Appears eligible.
3. Cooley Place Site (24 RB 1064)	Appears eligible.
4. Dusty Shelter Site (24 RB 1069)	Does not appear eligible.
5. Castle Rock Post Office and Homestead Site (24 RB 335)	Does not appear to be eligible.
6. Caskey 310 Site (24 RB 1076)	Does not appear to be eligible.
7. Lovelace Memorial Site (24 RB 301)	Does not appear to be eligible.
8. Petro City Site (24 RB 302)	Does not appear to be eligible.
9. P.E. Davis Rock Art Site (24 RB 875)	Does not appear to be eligible.
10. Connie's Gallery Site (24 RB 877)	Does not appear to be eligible.
11. Forsite Site (24 RB 878)	Requires additional work before eligibility recommendation can be made.
Potential Impact from Vandalism Only:	
12. Sly Bison Site (24 RB 267)	Appears eligible.
13. Insite Site (24 RB 874)	Appears eligible.

TABLE III-19 (Continued)

SUMMARY OF IMPACT TO CULTURAL RESOURCES

BUFFER ZONE

Sites	National Register Eligibility
14. McDonald Quarry Site (24 RB 303)	Does not appear to be eligible.
15. Rabbit Ridge Site (24 RB 310)	Does not appear to be eligible.
16. Rocky Top Site (24 RB 1061)	Does not appear to be eligible.
17. Wheatfield Vista Site (24 RB 876)	Does not appear to be eligible.
18. Pottery Site (245 RB 1062)	Does not appear to be eligible.
19. Sunburn Out Site (24 RB 881)	Does not appear to be eligible.
20. Normand Estates Site (24 RB 883)	Does not appear to be eligible.
21. Pigeon Site (24 RB 880)	Does not appear to be eligible.
22. East Fork Site (24 RB 886)	Requires additional work before eligibility recommendation can be made.
23. Albino Deer Site (24 RB 885)	Requires additional work before eligibility recommendation can be made.
24. How Dry I Am Site (24 RB 252)	Has been determined ineligible.
25. MAL 1401	Requires additional work to determine if this warrants a site description before National Register recommendation would be made.

The remaining nine sites would not be affected by blasting as they do not contain rock art or standing structures and do not appear eligible for the National Register.

If those sites needing additional testing and/or determined eligible for the National Register are to be disturbed by future mining, further cultural resource work would be required. Mitigation, through recording or other approved method, is required for the sites with rock art and standing structures prior to disturbance. If the company locates previously unrecorded cultural resources, they must notify the appropriate agencies and take steps to assure that valuable information on the sites is not lost.

Similarly, the portions of Area C life of mine plan outside of the proposal Block I mine site would be surveyed and mitigation requirements met in accordance with the National Historic Preservation Act prior to permitting.

N. AESTHETICS

Mining in Area C, Block I, would change all of the aesthetic values in the area to some degree, and would change them most appreciably during the life of the mine. Colors, textures, contrast, and relief would all be significantly altered during mining and after reclamation. Overall relief would be approximately the same in the reclaimed spoils, but topographic breaks in the mined areas that previously existed due to sandstone and clinker outcrops would be gone. Ponderosa pines in the mine area would be lost, perhaps permanently, thus altering texture, color, and contrast in the post-mine landscape. The revegetated slopes would have a generally uniform color and texture over the entire mined area and a noticeable contrast at the disturbed/undisturbed interface.

For the life of the mine, the noise levels in the area would increase due to heavy truck traffic, dragline operation, periodic blasting, and the conveyor system operation. Post-mine noise levels would remain high until all of the Area C (beyond Block I) mining activity is completed. Post-mine noise levels would eventually revert to pre-mine levels.

CHAPTER IV
ALTERNATIVES TO APPROVING THE PERMIT AS PROPOSED

This chapter presents alternatives to approval of Western Energy Company's proposed mine plan. Both administrative and technical alternatives are considered.

Administrative alternatives available to the Department of State Lands and OSM include taking no action, denial of the permit, selective denial of portions of the permit, and approval of the permit, subject to stipulations. Possible stipulations that would reduce environmental impacts identified in Chapter III are discussed in this chapter as technical alternatives. Any of these alternatives could be implemented if necessary to reduce the environmental impacts of the proposed project.

This chapter also discusses technical alternatives to the proposed action, including alternative mining methods and alternative energy sources; however, the Department is not empowered to require Western Energy to adopt any of the technical alternatives presented herein.

A. ADMINISTRATIVE ALTERNATIVES

1. No Action

Policy dictates that the Department must either approve or deny an application for a mining and reclamation permit within 240 days after receipt of a complete application. OSM has no legally required deadline for approval.

Montana does not have a formal administrative alternative to "defer action" following the receipt of a complete application for a mining and reclamation permit; however, the state may deem an application incomplete if the mine plan fails to meet state requirements. This action would lead to a postponement of the action, which has the effect of deferral. However, the Secretary of Interior has authority to defer approval of a mine plan for appropriate reasons.

2. Denial of the Permit

If the Department and OSM find the mine plan does not conform to the requirements of Montana's permanent regulatory program (ARM 26.4.301 et seq.), or the Federal Lands Program, then the agencies are obligated to deny the permit application. In the case of denial, it is likely that Western Energy would propose an alternative mine plan within Area C.

No mining would occur in Area C until a revised mine plan was submitted and approved; until that time, the land would continue to be subject to the effects of natural processes and to further discretionary modifications by surface owners.

Denial of the permit would almost certainly delay Western Energy's scheduled October 1983 coal delivery commitment to Colstrip Unit 3. Inasmuch as the boilers for Units 3 and 4 are being manufactured to conform with the characteristics of the Rosebud coal proposed to be mined from Area C, permit denial would require Western Energy to either reapply for an Area C permit or find another source of Rosebud coal to meet their contractual commitment to supply coal to Colstrip Units 3 and 4.

In the event that the Area C, Block I permit application was denied, Western Energy would still have the option of applying for mining permits on other undeveloped leaseholds, which could eventually replace the volume of coal proposed to be mined from Area C, Block I. However, plans and approvals for a new mine would take several years at this point, and there is no evidence that mining activities in other undeveloped portions of Western Energy's leasehold would have any less impact than the mining proposed for Area C, Block I.

3. Selective Denial

The Department and OSM have the option of denying Western Energy permission to mine in specified areas within the proposed permit boundary because of special, exceptional, critical, or unique characteristics, or where mining would affect the use, enjoyment, or fundamental character of adjacent land exhibiting any of the aforementioned characteristics. The impact analysis presented in this EIS has not identified any such lands in or adjacent to Area C, Block I, but that does not preclude the disclosure of such lands during the review of this EIS or subsequent review by the DSL technical staff. Additional permit application review is ongoing.

4. Permit Approval with Additional Stipulations

Possible stipulations that would reduce adverse environmental impacts identified in Chapter III are discussed in subsection B.3 of this chapter (Alternative Measures to Mitigate Adverse Impacts). Conceivably, any of these measures could become stipulations to the permit, if approved.

B. TECHNICAL ALTERNATIVES

Three technical alternatives have been considered: alternative energy sources, alternative mining methods, and alternative measures to mitigate adverse impacts.

1. Alternative Energy Sources

The need to mine in Area C, Block I is based on the continued demand for coal and a specific contract to supply Rosebud coal to Colstrip Unit 3. Inasmuch as the boilers for Units 3 and 4 are being designed to

accommodate the characteristics of the Rosebud coal, it does not appear likely that other sources of energy will replace Western Energy's market for Area C, Block I coal.

Alternative sources of energy, including oil and gas, nuclear, hydroelectic, solar, and geothermal, may replace or reduce the need for new coal-fired power plants in the future, but are not expected to replace coal-fired plants now in operation or under construction.

Fossil fuels such as natural gas and oil are being replaced by coal-fired units in response to the national move toward energy independence. Conversion of coal-fired boilers to oil or gas has been discouraged under federal policy. Electric generation from nuclear power has not increased as rapidly as once predicted because of high capital costs and a level of uncertainty concerning the safety of nuclear power plants. New sites for hydroelectric power generation are limited. Solar power (including direct conversion, wind, energy, and biomass utilization) is still in the developmental stage and is not likely to replace coal-fired generating units in the near future. Geothermal source areas are localized and it is unlikely that geothermal power will be able to provide electric power at the same scale as coal-fired generators.

Nationwide energy conservation programs have been demonstrated to reduce electric energy usage and slow the consumption of energy fuels, but it is unlikely that energy conservation measures alone would eliminate the need for additional power generation in the Pacific Northwest in the foreseeable future. Energy loads (from all energy resources) in the Northwest regional area have been projected to be insufficient to meet the area's needs through the year 1992 (Pacific Northwest Utilities Conference Committee, 1981).

2. Alternative Mining Methods

Several alternative methods to mine coal were suggested and subsequently discounted as being impractical in the Area B (Montana Department of State Lands, 1976) and Area B Expansion EISs (Montana Department of State Lands, 1980), including underground mining, auger mining, contour mining, and in situ mining. These methods have not been reintroduced as alternatives to the proposed mine plan for Area C, Block I because of the proximity of Area C to Area B and the similarity of conditions. The reader is refered to the discussion in the two referenced EISs if any further elaboration is needed regarding the rationale for eliminating these methods as viable alternatives to the proposed project.

In this section, two reasonable alternatives will be discussed: mining of the McKay coal seam and a realignment of the pits proposed at Area C, Block I.

a. Mining of the McKay Coal Seam

The Department could require Western Energy to mine the McKay coal, underlying the Rosebud seam, if the McKay coal proved to be marketable.

Currently it is not. Western Energy has been unable to find a suitable market for the McKay coal due to its inferior quality. The McKay has an average sulfur content of about 1.31 percent (by weight), which is half again as high as the Rosebud (at 0.87 percent). Additionally, there are other "problem" constituents in the ash, namely iron (Fe) and sodium (Na), whose percentages are greater than the Rosebud. Increased iron content promotes boiler slagging at normal operating temperatures and increased sodium content tends to promote boiler tube deterioration (Western Energy, 1981).

In recognition of these problems, the Montana Board of Natural Resources and Conservation has prohibited the use of McKay coal in Colstrip Units 3 and 4, both as an exclusive fuel source and in combination with Rosebud coal (Western Energy, 1981).

The possibility still exists that Western Energy could find a buyer for McKay coal or blended McKay-Rosebud coal, and the Department continues to encourage Western Energy to find such a market. If McKay coal was mined in Area C, Block I, special handling, new equipment, and a revised mine plan would be required to provide separate handling of the McKay coal. The current contract calls for the sale of Rosebud coal only from Area C, Block I, and the equipment that would be used to extract coal from Area C, Block I is contractually dedicated to the fulfillment of that contract. Under the terms of the contract, Western Energy cannot divert any dedicated production equipment to uses other than fulfillment of the contract. In effect, this restriction tends to eliminate the possibility of producing small quantities of McKay coal in response to intermittent market demand. Thus, Western Energy would need to purchase and dedicate additional mining equipment to mining the McKay seam, and make necessary modifications to the proposed mine plan, which is currently designed to recover the Rosebud seam alone.

The McKay seam averages about eight feet in thickness throughout the proposed mining area, and represents about ten million tons of coal. The interburden between the McKay and the overlying Rosebud seam averages about 23 feet in thickness. Western Energy contends that, given a market, only a large-scale contract (1.5 to 2 million tons per year) would prove to be economically feasible at this time. Mining of the McKay would cause an increase in the depth of the pit by about 31 feet, which would require a permanent adjustment to the proposed mining plan. Decreased sidewall angles would be required to accommodate a deepened pit, resulting in escalated costs to remove the overburden and a larger disturbance area.

Mining both the McKay and Rosebud seams in Area C, Block I would recover approximately one-third more coal per acre disturbed, resulting in a commensurate increase in severance tax royalties to the state and possibly slow the rate at which new acreage is disturbed at Colstrip. On balance, noneconomic environmental impacts would increase slightly as a result of taking both seams, especially as a result of increased surface disturbance and the mixing of interburden with overburden materials. Higher concentrations of total dissolved solids (TDS) would probably occur in the spoils groundwater (refer to the Technical Support Document).

b. Pit Realignment

On April 28, 1982 the BLM received bids on federal coal leases throughout the Powder River Basin, including tracts located within Western Energy's Area C mine boundary totaling 892.56 acres. Western Energy was the only bidder. The USGS and BLM are currently analyzing these bids. A legal challenge to the sale has been filed by the National Wildlife Federation in U.S. District Court.

In the event that these tracts are obtained, Western Energy has developed an alternative mining sequence in Area C, Block I (Figure IV-1) to accommodate these lease tracts. The revised mining sequence depicted in Figure IV-1 is considered to be a viable alternative to the proposed project, and as such, it has been assessed and compared with the impact from the proposed project.

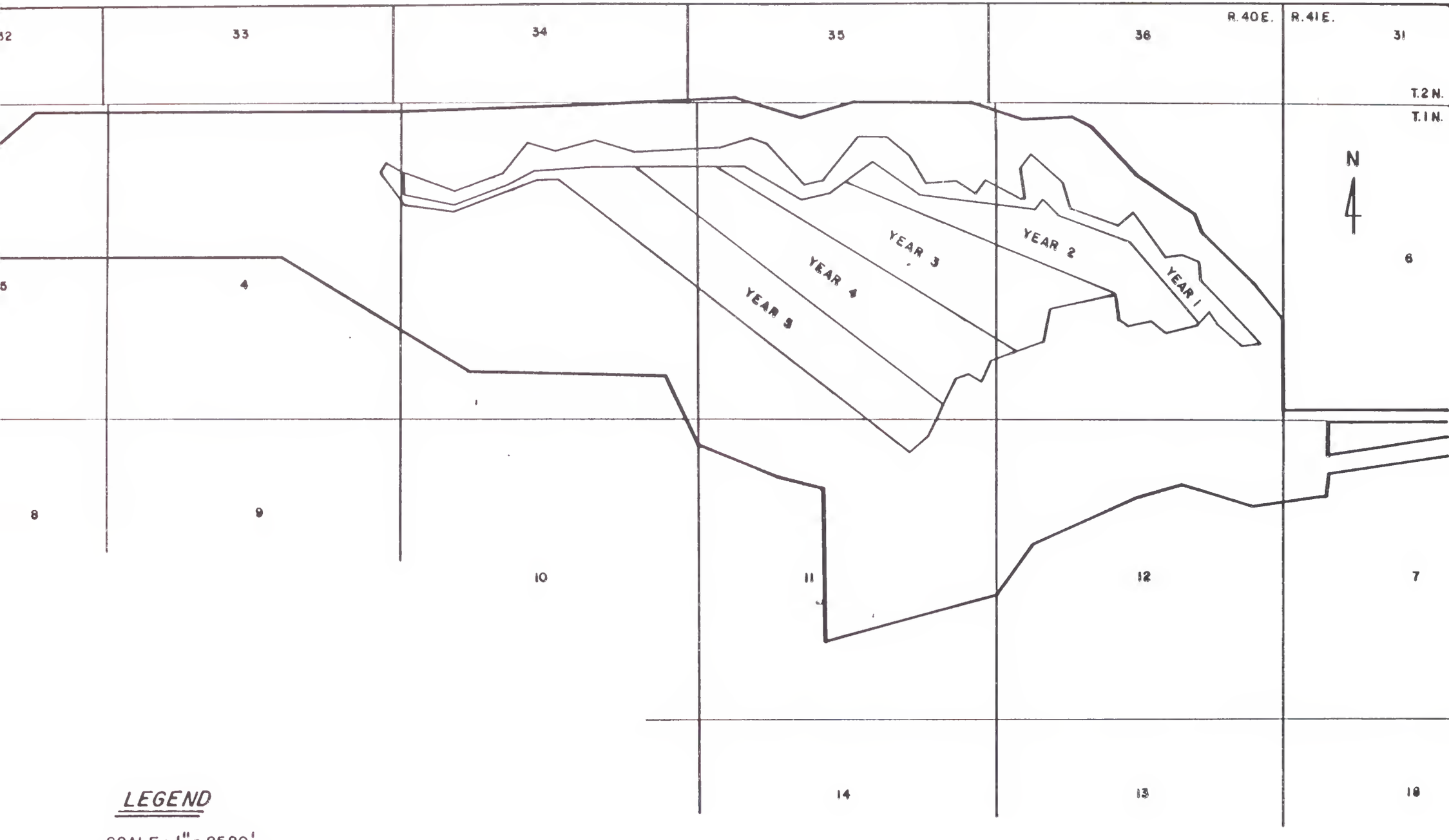
1) Geology

Western Energy engineers indicated that the mining method would be somewhat altered in Block I if the pit realignment alternative was implemented (personal communication during the October 1981 mine visit). Specific overburden handling information was not available from Western Energy; however, the engineers did indicate that overburden in excess of 100 feet would be removed by scrapers and stacked prior to the dragline moving in to strip the remaining overburden.

Since the upper sections of deeper overburden are predominantly sandstone in Area C, Block I, the placement of this overburden during reclamation has a significant bearing on the replaced overburden geochemistry. If this high percentage sand material is not mixed with the dragline spoils, then the bulk geochemistry of the spoils would not be that of the composited hole geochemistry shown in Chapter II, Table II-2. Not mixing the sand and dragline spoils would result in relatively higher average trace metals content in the dragline spoils than that shown in Table II-1 for some of the interior holes in Area C. Also, placement of the high sand spoils over the dragline spoils during reclamation could result in near-surface spoils with sand contents in excess of DSL suspect levels (i.e., greater than 70 percent sand).

This alternative would involve removal of all the sandstone ridge in Area C, Block I, and would result in a greater alteration of the visual appearance of the reclaimed area. In addition, this alternative would leave essentially no undisturbed rock in the permit area, whereas the Block I plan leaves an undisturbed sandstone ridge in part of the southern permit area. Other impacts would be the same as those for the Block I mine plan.

The reorientation of the pits would result in an overall increase in coal recovery from the Area C, Block I permit area. The pit realignment alternative would add approximately 400 minable acres to the Block I permit area with in situ coal reserves of approximately 16.3 million tons in the Rosebud seam. The amount of this additional resource that Western Energy would recover in the first five years of mining with the revised pit orientation is not known, but it is likely that production would be approximately the same for either pit orientation for the first year.



LEGEND

SCALE : 1" = 2580'

—— PERMIT BOUNDARY

2) Hydrology

The revised mining sequence would have no significant impact on groundwater flow. The nature of drawdown around the pit, the shape of a cone of depression in the Rosebud potentiometric surface and the extent of drawdown with time would remain effectively the same as they would be subject to the original mining sequence.

Since the revised mining sequence would disturb more area and would remove much of the sandy overburden prior to use of a dragline, some minor effects may result. First, the placement of sandy overburden at the surface unmixed with lower, finer spoil may slightly increase groundwater recharge potential. Second, if finer-grained spoils containing more leachable salts are mixed with sandy overburden, higher TDS values for groundwater may occur. Although this increase is not expected to be large, the exact increase in TDS concentrations cannot be accurately predicted with the existing data base.

3) Climate

No impact.

4) Air Quality

If the leases are acquired and the proposed mine plan is changed to reflect the alternative pit progression shown in Figure IV-1, the location of the sources of air emissions will change. However, because the coal and overburden removal rates do not change, the rates of emission would not change significantly. The alteration in pit location was examined in detail and the air quality model layout was revised to account for the different pit and spoil area locations. Trial calculations were performed and it was concluded that differences in air quality, deposition, and visibility impacts from those predicted in Chapter III would be very small and confined to the immediate area surrounding the mine. Therefore, the impacts predicted in Chapter III are assumed to apply to this alternative as well.

5) Noise

The impacts would be essentially the same as those for the proposed project, as discussed in Chapter III.

6) Soils

The reorientation of mining passes would result in the disturbance of more land by mining. Of the land to be disturbed, more undeveloped

rangeland supporting ponderosa pines and junipers would be disturbed. Adapted soils may not be available for successful reestablishment of even a portion of these vegetative types.

If excessively sandy overburden materials were placed near the surface (see Geology, Section A), the droughty condition of these materials as substrata would limit reestablishment and long-term vigor of revegetated communities. Placement of excessively sandy overburden in areas that may experience gully development or the migration of head-cutting would increase the potential of deep gully development.

The placement of sandy overburden material in the lower portions of mined-out pits would avoid this additional impact for the reoriented mine pits.

7) Vegetation

The reorientation of pits would result in the disturbance of additional conifer-shrubland and sagebrush shrubland areas. It is not certain whether ponderosa pine or skunkbush sumac, important species in the conifer-shrubland areas, can be reestablished on the regraded spoils (Section III-G). This alternative would result in an increase of good condition grassland for grazing and a decrease in vegetatively diverse types, especially ponderosa pine stands.

8) Wildlife

Wildlife effects of pit realignment would not be appreciably different. This alternative would disturb slightly more woodland, but as with the proposed action, would not disturb the golden eagle nest site. Of greater concern is the implied long-term commitment of the Block II alternative to a pattern of mining through the raised topography, which includes the sandstone cliff features of value as raptor nesting sites.

9) Sociology and Economics

Socioeconomic impacts would be identical to those described for the Block I plan, discussed in Chapter III.

10) Land Use

Most of the disturbance to cropland and rangeland under the pit realignment alternative would be similar to that identified under the proposed project. A portion of the cultivated field in the northwest section of the permit area that would be disturbed under the Block 1

mining plan would not be disturbed as a result of pit realignment. This amounts to about 80 acres of cropland that could remain in production for five additional years; however, the presence of mining activity on the northern portion of the field may make cultivation of the southern portion impractical. The extent of rangeland disturbance will be similar to that of the proposed plan, with a decrease in disturbed acreage in the northwest section of the permit area, and an increase in the disturbed acreage in the center of the permit area.

11) Transportation

Transportation impacts would be identical to those described for the Block I mining plan, discussed in Chapter III.

12) Recreation

Recreation impacts would be identical to those described for the Block I plan, discussed in Chapter III.

13) Cultural Resources

The impacts of the pit realignment alternative on the cultural resources located within Area C, Block I and its one-mile buffer zone would remain the same as those discussed in Chapter III. Determination of impact on most of the cultural resources cannot be made until the final archaeological report on the sites has been released, reviewed by the Montana SHPO, and a determination of National Register eligibility has been made.

14) Aesthetics

The effect of pit realignment would not significantly differ from the impacts discussed for the proposed project, except that more forested acreage and more topographic diversity would be eliminated by mining through the sandstone ridge, instead of around its perimeter.

3. Alternative Measures to Mitigate Adverse Impacts

The following alternatives are presented as measures designed to mitigate the adverse impacts discussed in Chapter III.

a. Geology

Because of the significant increase in trace metal content in the five to ten feet of shale lying directly above the Rosebud coal, some method of selective removal of that zone in stripping overburden might be considered. A method that would prevent mixing that zone with other spoils and keep it below the top ten feet of reclaimed spoils would be very effective in minimizing, and in many cases eliminating, anomalous nickel, cadmium, and molybdenum values in the near-surface spoils. Possible methods include loading and hauling this material for later selective placement in the spoils or selective dumping of this material with the dragline to insure it does not end up on top of the spoils pile. The latter method would be more economical and probably easily achievable.

Field mapping could determine if significant faulting exists where it is inferred in portions of Block I. If present, then such faulting should be incorporated into Western Energy's surficial geology map and into the mine engineering plan for the pit realignment alternative mine plan. Engineering planning that recognizes any significant faulting could mitigate its effect on coal recovery in Area C.

Settlement problems can be mitigated with nominal bulldozer grading. It is expected that future subsidence problems will be small (under four feet of differential vertical displacement), can be mitigated by back-filling and regrading, and will occur soon after initial spoil grading. Subsidence problems are expected to be evident well before the end of the ten-year bonding period.

b. Hydrology

Western Energy's Rosebud Mine, Area C will affect the existing environment. Mitigation techniques proposed or recommended to alleviate long-term environmental degradation are presented in the following sections.

a) Groundwater

There are very few mining or engineering practices of a practical nature that can be used to mitigate potential groundwater impacts. However, one of the few possible means of mitigating groundwater flow changes is by employing truck-and-shovel mining methods instead of using a dragline. The nature of spoils (as replaced by truck-and-shovel) can be hydraulically different than spoils replaced by a dragline. A truck-and-shovel operation could create and replace spoils that more closely approximate the vertical permeabilities and porosities of undisturbed

coal and overburden. A truck-and-shovel operation tends to break up overburden less than a dragline, and can also recompact the spoils once they are replaced.

Greater compaction causes lower porosities in the spoils, which could allow for a quicker recovery of groundwater levels. Given a constant rate of inflow to spoils from any source, it would take, for example, half as long to fill up a given volume of spoils with 10 percent porosity as opposed to the same volume of spoils with 20 percent porosity. However in Area C, for example, the predominant source of groundwater recovery in reclaimed spoils would come from infiltration of precipitation. In this situation, the greater compaction of spoils by truck-and-shovel as opposed to a dragline operation would inhibit groundwater recovery because the extra compaction would limit vertical permeability, and hence infiltration. Since recharge from infiltration in Area C and most of the other mine areas is an important contribution to the regional flow system, it is important that recharge capacity be maintained. It appears that, all things considered, a dragline operation would create spoils more conducive to recharge and groundwater recovery than would a truck-and shovel operation.

b) Surface Water

The major impacts to the surface water regime from mining that can be mitigated are geomorphic instability and accelerated erosion. Geomorphic stability is largely determined by regional landscape units. In reclaimed areas, the stability of geomorphic landscape units is strongly influenced by reclamation techniques. Two of the primary factors that affect sediment yields from reclaimed landscape units are the nature of surficial materials and the topography, both of which should be the focus of design and management efforts. The following strategies were recommended by Ertec, Inc. to prevent instability and accelerated erosion.

o Alternative Reclamation Practices and Engineering Techniques

Studies on currently reclaimed areas suggest that infiltration rates and sediment yields from reclaimed sites are strongly correlated with the methods of topsoil placement and machine handling of the spoils. Dollhopf et al. (1977) determined that reclamation treatments (in this case, the use of bulldozers) that compact the spoils result in greater runoff and erosion rates. To avoid such problems, alternative reclamation practices, such as the use of chisel plowing techniques, could be employed.

o Soil Handling Mitigation Measures

Many of the soils in the Colstrip area are fairly erodible due to the high proportion of fine sands, which may result in high sediment yields from reclaimed areas. A range of measures (discussed in detail in Soils, Section F) could be applied to mitigate this effect. These measures could include mixing the salvaged topsoil or using surface stabilization techniques to minimize erosion prior to the successful establishment of vegetation.

o Topography Changes to Minimize Instability

Another factor that could be considered in large-scale landscape design is the post-mine topography. The current mine plan follows DSL regulations as to the gradient of reclaimed hill slopes. Slope length and shape also significantly affect erosion rates and must be considered in the landscape design. Experience gained during the early stages of reclamation could lead to the modification of the designed post-mine topography to minimize areas of potential instability.

o Subsidence and Soil Piping Mitigation

Geomorphic instability due to subsidence in the spoils materials may take three forms: area-wide settling, localized subsidence or collapse, and piping.

As discussed in Chapter III, area-wide settlement is likely to be less significant than in many other reclamation sites in Montana. However, the equipment used in handling the spoils is also a critical factor, and settlement is likely to be minimized if the reclaimed areas are contoured by scrapers rather than bulldozers, particularly if contouring is accomplished in winter (Groenweld and Rehm, 1980).

Localized subsidence, which may continue for a longer period following contouring, is also strongly affected by handling techniques and equipment. Groenweld and Rehm (1980) suggest that this type of subsidence can also be avoided if bulldozer contouring is restricted during winter months.

Mitigation measures to control piping and other types of settlement could include a range of controls on stability, such as: selective placement of sodic spoils away from the geochemically active surface zone to mitigate surface cracking; selection of appropriate handling equipment; using techniques to avoid differential compaction, and an awareness of the importance of environmental factors, notably the potential freezing of spoils during contouring and reclamation.

o Gully Control

At the scale of the drainage basin within the mined area, stability can best be achieved by integrating the smooth upward-concave profiles of the reclaimed stream channels with the hill slopes within the basin, as well as with the upstream and downstream drainages. The reclaimed basins described in Western Energy's mine plan achieve this by approximating the original slope of the stream channels, and by grading the tributaries into the main channels so that no knickpoints are created. However, because of the inherently unstable nature of ephemeral drainage systems and the engineering considerations of reclamation, some instability problems may occur that require further mitigation measures. One of these problems is the development of gullies.

The relevant scales of operation for dealing with gully erosion include both the drainage basin, where runoff must be controlled, and the channel, where a stable form must exist. To be effective, attempts to control gullying must be comprehensive and the problems must be correctly identified. Gullies may develop from surface erosion when

runoff is concentrated by small depressions and knicks on a hill slope, or from subsurface erosion (piping) and the collapse of pipes. Measures to deal with the first type of gully development may not help and may even aggravate the problem of subsurface erosion. A further difficulty is in identifying the main source of sediment, which may be the adjacent hill slopes, the gully head, or the channel bed and banks further downstream.

Measures to control gullying should concentrate on reducing runoff. To control surface runoff, the stream channels, gullies, and surrounding headwaters can be mulched or vegetated to increase roughness, decrease flow velocity, and induce infiltration. The treatment can be supported by building temporary dams in each channel to trap sediment and thereby reduce channel depth and slope.

For subsurface erosion, a more uniform pattern of infiltration and soil water movement must be achieved. Mechanical measures such as diversion ditches and terraces often used to control surface runoff are inappropriate. By causing ponding, they provide a concentrated supply of water that may open a new piping system or increase erosion in an existing one. Control of subsurface erosion is best achieved by establishing a healthy grass cover, or where conditions are marginal for improved pasture, a mixture of shrubs, grasses, and trees. If tunneling has reached an advanced stage, the tunnels must be broken up by ripping prior to establishing the vegetative cover.

Conservation measures in the channel may include reshaping gullies to a more stable design. If such land-forming operations are impractical, simple mechanical controls can be employed such as earth and brush dams, boulders, or planks to form barriers across the channel. These induce sedimentation and change the slope in both the main gully and the tributaries. Such temporary dams have a high risk of failure. Therefore, they must be carefully constructed, anchored, and regularly maintained.

A range of stability problems can be associated with the mine highwall and its reclamation. These include gully incision on the highwall reduction slope, differential erosion between the coherent bedrock and the spoils, piping, and mass wasting at the highwall.

Many gullying and piping problems at the highwall may be managed using the techniques described above and the careful design of the highwall reduction slope to minimize instability. At a broader scale, an alternative approach to mitigating the problems of stream instability at the highwall may be by bluff extension. Using this approach, a step within the stream longitudinal profile may be left within the more resistant bedrock at the highwall. At the base of the bluff, an armored plunge pool can be constructed to dissipate the energy of the stream. Downstream from the plunge pool the stream flows at a gentler gradient over the more erodible reclaimed spoils, reducing the potential for incision and accelerated erosion. However, highwall stability problems may result using bluff extension methods, in the form of slumps and rockfalls. These concerns can be addressed throughout mining and reclamation and the appropriate actions taken to solve them.

o Roadway Sediment Mitigation

Within post-mine landscapes, which are stable at the large scale, problem areas may exist where erosion rates are extremely high and these areas are major sources of sediment. A problem that may be managed using agronomic or engineering techniques is that of increased erosion associated with roadways and other developments.

The main problems associated with roads are excess runoff, and the stability of the road cuts and fills. In erodible areas, roads may be placed on ridges to minimize the catchment area from which runoff originates. Even so, excess runoff cannot be entirely mitigated because whenever the ridge slopes into saddles or along spurs, erosion by overland flow and gullying can occur. Grass-lined side ditches, with regularly spaced culverts, could provide an effective method of runoff control. Various techniques to improve road cut and fill stability include: benching, which is used to reduce the overall slope angle of the bank, establishment of herbaceous plants, construction of diversion ditches and spillways to dispose of runoff, and use of erosion nets.

c. Climate

No recommendations.

d. Air Quality

A number of alternative stipulations were investigated. These include:

- Application of alternate dust palliatives to calcium chloride on the haul roads
- Addition of foaming agents to the coal to reduce dust production during handling
- Installation of water injection systems on the drilling units
- Enclosing the emergency stockpile

However, if all of the above measures were taken, dust emissions would be reduced by less than one percent. Therefore, these stipulations would not result in a significant change to the analysis of impacts.

e. Noise

Although ambient sound levels from Area C mining are not expected to be a significant nuisance in Colstrip, mine construction and operation activities may noticeably increase sound levels at locations closer to

the mine or at locations where ambient sound levels are now very low. Measures can be taken to reduce potential impacts due to equipment and blasting noise.

Noise produced by mining equipment is best minimized by using equipment designed to operate quietly. Proper muffling and maintenance of equipment during its operational lifetime is also effective.

Specific techniques are available for minimizing blasting noise. Special attention to overcharged blast holes, adequate stemming, covering the detonating cord, and using adequate burdens is important in minimizing noise production.

The special effect certain meteorological conditions can have on sound propagation through the atmosphere should also be considered. One rule of thumb for minimizing blasting impacts is to postpone the blast if a temperature inversion exists at less than 5,000 feet and the affected community is downwind of the blast. Since low temperature inversions are frequently observed at night and during the first several hours after sunrise, special care should be taken during these hours. Another rule of thumb is postponing blasting when the affected community is downwind and the wind speed is greater than 15 mph.

f. Soils

1) Selective handling of soil by textural types would mitigate against the elimination of diverse soil types and the related impacts of reduced vegetative diversity. This is presently being done to a limited degree in other areas at the Rosebud Mine for sandy soils (see discussion in Chapter III). Soils that must be stockpiled from haul roads, clinker pits, facility areas, the boxcut reduction zone, and the first three mining passes could be stored separately for placement in specific areas, increasing the long-term survival potential of some vegetative types.

The boxcut reduction zone and first three mining passes comprise 438 acres, including 86 acres of clinker soils. If salvaged to the depths shown in Appendix F, the clinker material from this area is sufficient to reclaim the entire 60-acre area projected for ponderosa pine plantings with total depth of 30 inches of mixed clinker soil material, or to reclaim a larger area with 10 to 12 inches of clinker material over a 15 to 20 inch loosened subsoil layer. Ponderosa pine have a higher tolerance for rock fragment content in soils, thus allowing salvaging to greater depths of this material than proposed. This would further maximize the use of this resource. This alternative would increase the likelihood of tree survival, and due to the location of ponderosa types on hill slopes, it would reduce the potential for erosion in these areas.

2) In the long term, cropping patterns after mining can be expected to follow the same pattern as on the pre-mine landscape, which is that only loamy and clayey soils can be cropped, because yields on these soils are consistent enough to allow economical cropping.

Therefore, areas in which cropland will be the post-mined land use should be respread with loamy or clayey soil materials. The isolated location of projected cropland areas (mine shop and topsoil stockpiles, see Figure I-8) will be helpful, in that the loamy and clayey soils salvaged from each area can be stored nearby for replacement. The only additional impact that will result will be a reduction in organic matter and soil microorganisms during storage and potential soil compaction during soil replacement (see following mitigations).

3) Topsoil degradation during storage is due in large part to oxidation of organic matter and the establishment of increased populations of pathogenic microbial species, which attack viable plant parts in stored soil (see Chapter III, Section F). A way to decrease both of these processes is to store dry soil, allow compaction of the pile as lifts are placed, and to leave as little surface area as possible within limits of the erosion criteria for stockpiles after the final stockpile configuration is completed.

4) The reduction of organic matter in the soil after storage, or to a lesser extent, after direct hauling, can be tempered by incorporating mulch on all reclaimed surfaces immediately after the first phase of seeding, or by using a cover crop as discussed in Section g. This will improve the moisture and nutrient holding capacities of the surface soil, reduce the tendency of the surface to crust, and improve infiltration. It will also provide a base for the reestablishment of important soil microorganisms.

5) Increased bulk density in applied soil layers can be mitigated by using the bulldozer-mounted ripper bars to scarify replaced soil. Spot-checking of subsoil bulk densities prior to the placement of the next lift would aid in identifying the areas where bulk densities exceed 1.5 g/cm^3. If ponderosa pine plantings are to be located on non-selecting handled topsoil, it may be necessary to achieve bulk densities of 1.3 g/cm^3 (Chapter III, Soils) or less.

g. Vegetation

1) Seeding Method

Although the two-phased revegetation method is expected to produce satisfactory results as stated in Chapter III, no data could be found recommending this method over more conventional seeding methods. While it was developed in an attempt to increase species diversity in reclaimed areas that had otherwise demonstrated limited diversity, it has two apparent drawbacks. One is the waiting period of up to three years between seeding sequences, which considerably delays the establishment of effective grass cover. The other is the possibility that aggressive annual weedy species may be equally or more competitive to the first planting sequence than the second seeding sequence would be. Weedy plants may also hinder establishment of the second phase.

A suggested alternative is one that has become standard for seeding native grasses in the Great Plains. This method entails growing an

adapted annual cover crop on a prepared seedbed to produce a standing stubble, and then direct seeding the desired mixture into the standing stubble. This method improves soil moisture, reduces soil temperatures, and has been shown to give a ten percent greater population of native grasses as opposed to using a protective cover of straw mulch (Schuman et al., 1980). Seeding could be done either in late fall or early spring and would require the use of a double-disk grass drill capable of seeding in untilled stubble and capable of handling the diverse seed mixture.

This method has the advantages of a firm seedbed, which is essential for warm-season grasses, good contact between seed and moist soil, greater soil moisture from trapped snow, reduced surface evaporation, and reduced soil temperature fluctuations. Erosion and weed infestation would also be minimized.

2) Establishing Conifers

The reclaimed soils at Colstrip are essentially grassland soils rather than woodland soils. Extensive experience with conifers as windbreak plantings (Ferber, 1974) and in forest plantings (Larson and Schubert, 1969) strongly suggests that young trees cannot compete with weeds and grass for moisture on grassland soils. To achieve success in reestablishing a conifer vegetative community, special measures to enhance the storage and availability of soil moisture must be employed.

(a) One alternative is to place rocky or coarse sandy soil having rapid infiltration and percolation at the surface to a zone below the reach of most grass roots (12 to 16 inches, Larson and Schubert, 1969). The porcelanite or clinker beds would provide a good source for materials to build this special soil.

(b) Another alternative entails regular maintenance practices to eliminate competing grasses and weedy forbs. Methods to accomplish this include cultivation, application of herbicides, mulching, or supplemental irrigation. One or more of these methods must be used to control competitive plants until root systems of the trees are well established.

Revegetated conifer zones would require an extended period of protection from grazing and trampling by livestock or wildlife. Fencing of these areas should be considered when the adjacent revegetated range site is ready for grazing use.

3) Reestablishment of Range Sites

Sandy and silty soil material should be identified, segregated, and reapplied on the graded spoils to reestablish areas of sandy and silty range sites in large enough areas to establish discrete plant communities. This would allow vegetative seed mixtures to be tailored to the adapted climax community for each soil. The proposed deferred-rotation-grazing system could then be applied to the reclaimed area in recognition of the specific growth habits of the key species on each site. This would allow for increased spatial and species diversity, and possibly lengthen the period of optimum grazing use on the reclaimed areas.

h. Wildlife

Where impact to important habitat components is unavoidable, it may be possible to mitigate or compensate for such impacts via the following activities:

- Continue sponsorship of investigations into restoration of conifer habitats with a long-term goal of establishing the extent and composition of habitat comparable to the existing conifer habitat. Because of the long recovery time for these woodlands, additional attention should be directed to establishing shrub communities to supply improved diversity, cover, and forage in the near term.

- Examine feasibility of creating cliff habitats where mining abuts steep and precipitous terrain.

- Evaluate design considerations for post-mining topography and anticipated post-mining hydrologic characteristics to provide comparable surface water supplies for wildlife and enhancement of these areas for wildlife use. These design features may include retention of sediment ponds, creation of small stock-pond type impoundments, or water-well aquifer pumping to stock ponds or tanks.

- Evaluate feasibility of incorporating plans to replace particular microhabitat features such as rock areas or brush piles.

i. Sociology and Economics

During the period of peak construction-induced population, 1982 to 1985, the Rosebud County Sheriff's Department should ensure that adequate coverage is available during the evening shift in the Colstrip area. If necessary, the department should hire an additional deputy for the area.

Solid waste collection should be limited to one day per week pickup, which normally is sufficient for residential purposes.

The Colstrip Mental Health Center may have to add part-time professional or paraprofessional staff.

The Sunlight Development Company should carefully monitor the housing supply/demand situation in late 1982. If more doubling up does not occur, or the construction schedules do not lag, a housing supply deficiency of about 60 units may occur. Adequate housing should be provided for all construction employees.

j. Land Use

Presently cultivated land could be reclaimed as cropland instead of as rangeland. The treatment of the land during reclamation would

not be much different under this scenario. Avoiding over-compaction of the overburden and avoiding pockets of high electrical conductivity would increase the crop potential of the reclaimed land (see Section F, Soils). Planting the reclaimed land to rangeland and allowing establishment of vegetation and nutrient cycling during the period prior to bond release would increase the potential for productive cropland after bond release. If the cultivated land was reclaimed to cropland instead of rangeland immediately after disturbance by mining activity, there would be an increase in erosion potential on that land due to a lack of vegetative cover during part of the year. Therefore, although immediate reclamation to cropland would result in harvestable crops at an earlier date, the long-range productivity of the cropland would be increased by allowing the land to return to rangeland prior to any post-mining cropping.

k. Transportation

No recommendations.

l. Recreation

The Stillwater Park Complex should be completed as soon as possible. CARPA and the school district should continue to explore means for cooperating on the availability and use of school facilities.

m. Cultural Resources

No mitigation plan is yet available for review.

n. Aesthetics

Mitigating measures to lessen the impact on aesthetic values include the construction of complex slopes on reclaimed spoils; leaving parts of the highwall as topographic breaks, especially where highwall reduction would necessitate timber removal; using neutral-colored paint on buildings, the coal conveyor, mining equipment, etc., appropriately colored to blend with the existing environment; controlling fugitive dust via the methods recommended in Section D (Air Quality); and eventual revegetation using plant species similar to adjacent undisturbed acreage. Such measures would tend to lessen the unnatural contrasts that occur during mining operations and would also enhance the natural contrast, color, and texture in the post-mine environment.

CHAPTER V
CONSULTATION AND COORDINATION

A. DEVELOPMENT OF DRAFT ENVIRONMENTAL IMPACT STATEMENT

Information used in the preparation of this Draft Environmental Impact Statement was obtained from the following agencies and companies:

Federal Agencies

U.S. Department of Agriculture
- Agricultural Research Service
- Forest Service
- Soil Conservation Service

U.S. Department of Interior
- U.S. Geological Survey
- Bureau of Land Management

State Agencies

Montana Department of Health and Environmental Sciences
Montana Department of Highways
Montana Historical Society - State Historic Preservation Office
Montana Department of State Lands
Montana Department of Natural Resources and Conservation
Wyoming Department of Environmental Quality

Companies

Bison Engineering (Subconsultant - Air Quality)
Western Analysis, Inc. (Subconsultant - Socioeconomics)

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B. REVIEW OF THIS STATEMENT

In accordance with DSL's and OSM's regulations governing environmental impact statements (EISs), copies of this draft EIS will be made available to the public for comments and suggestions. All comments received will be carefully considered in the preparation of a final EIS. Written comments should be sent to Commissioner Gareth Moon, Department of State Lands, Capitol Station, Helena, Montana 59620.

The draft EIS is available for review in the following places:

- Montana Department of State Lands, 1625 11th Avenue, Helena, Montana
- Big Horn County Public Library, 419 North Custer Avenue, Hardin, Montana
- Miles City Public Library, 1 South 10th, Miles City, Montana
- The Rosebud County Library, 201 North 9th Avenue, Forsyth, Montana
- Bicentennial Library of Colstrip, 320 Water Avenue, Colstrip, Montana
- Parmley Billings Public Library, 510 North Broadway, Billings, Montana
- Sheridan County Fulmer Public Library, 320 North Brooks, Sheridan, Wyoming
- Montana State Library, 930 East Lyndale Avenue, Helena, Montana
- Office of Surface Mining, 1020 15th Street, Denver, Colorado
- Office of Surface Mining Area Office, 935 Pendell Blvd., Mills, Wyoming

A limited number of copies are available on request from the Department of State Lands, Capitol Station, Helena, Montana 59620.

Technical Support Documentation is on file with the following entities:

- Montana Department of State Lands Reclamation Division, 1625 11th Avenue, Helena, Montana
- Montana Department of State Lands EIS Team, 1539 11th Avenue, Helena, Montana
- Office of Surface Mining, Department of Interior, 1020 15th Street, Denver, Colorado

- Bicentennial Library of Colstrip, 320 Water Avenue, Colstrip, Montana
- Western Energy Company

CHAPTER VI

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CHAPTER VII

APPENDICES

APPENDIX A

TABLE A-1

MONTANA DEPARTMENT OF STATE LANDS
SUSPECT LEVELS IN OVERBURDEN AND TOPSOIL MATERIAL

Analysis	Suspect Level
Electrical Conductivity.....	>4-6 mmhos/cm
Sodium adsorption ratio.....	>12 (meq/liter)$^{1/2}$
Mechanical analysis.....	Clay >40% Loamy sand and sand
Saturation %.....	none
pH.....	>8.8-9.0
PO_4-P.....	none
NO_3-N.....	variable
NH_4-N.....	unknown
Cd.....	>0.1-1.0 ppm
Cu.....	>40 ppm
Fe.....	unknown
Pb.....	pH < 6, >10-15 ppm pH > 6, >15-20 ppm
Mn.....	>60 ppm
Hg.....	>0.4-0.6 ppm
Se.....	>2.0 ppm
Mo.....	>0.3 ppm
B.....	>8.0 ppm
Zn.....	>30-40 ppm
Ni.....	DTPA extraction: >1.0 ppm

mmhos/cm = millimhos per centimeter (EC x 10^3 @ 25°C)
meq/liter = milliequivalents per liter
ppm = parts per million
DTPA = Diethylenetriaminpentacetic Acid

APPENDIX B

TABLE 1

SUMMARY OF QUALITY OF WATER FROM THE SEVERAL AQUIFERS IN AREA C AND THE ENTIRE ROSEBUD MINE AREA
(Concentrations Expressed in Milligrams per Liter Unless Otherwise Noted)

Aquifer	Number Wells	Specific Conductance Micromhos/cm	Total Dissolved Solids	Total Hardness	Calcium	Magnesium	Sodium	Bicarbonate	Sulfate	Chloride
Rosebud Spoils										
Average Rosebud Mine	35	3,639	3,298	2,354	336	363	166	700	2,015	23
Range	35	1,576-10,825	1,044-10-619	548-6,251	64-580	84-939	20-1,648	205-3,750	417-1,587	0.0-177
Valley Fill Material										
Average Area C	8	2,660	2,460	1,530	169	264	157	538	1,350	16
Average Rosebud Mine	40	2,982	2,767	1,778	257	268	177	536	1,629	20
Range Area C	8	1,670-4,040	1,350-4,680	837-2,430	114-287	135-417	46-279	486-581	584-2,500	2-45
Range Rosebud Mine	40	1,670-4,530	1,340-5,160	837-3,240	114-718	129-613	46-493	183-678	584-3,140	2-95
Rosebud Overburden										
Average Area C	3	2,046	1,782	1,168	172	180	110	491	955	15
Average Rosebud Mine	22	1,491	1,246	844	102	143	82	481	620	12
Range Area C	3	620-2,968	400-2,536	309-1,794	53-262	43-276	11-176	310-662	74-1,472	8-30
Range Rosebud Mine	22	500-3,150	335-3,098	306-1,794	19-278	43-297	7-462	21-1,202	71-2,056	1-81
Rosebud Coal										
Average Area C	14	1,850	1,660	921	138	148	131	466	794	8
Average Rosebud Mine	55	2,111	1,888	1,206	176	186	132	573	985	14
Range Area C	14	540-5,540	334-6,520	239-2,840	42-284	33-517	11-536	304-684	57-3,390	1-32
Range Rosebud Mine	55	540-5,540	334-6,520	142-3,590	29-581	17-521	10-536	25-1,128	57-3,390	0.5-109
Rosebud/McKay Interburden										
Average Area C	2	2,415	2,180	1,125	201	152	221	555	1,112	6
Average Rosebud Mine	15	2,173	1,770	1,044	211	123	176	503	959	12
Range Area C	2	1,940-2,890	1,660-2,700	1,050-1,200	156-246	143-162	104-338	540-570	774-1,450	4-8
Range Rosebud Mine	15	703-3,760	538-3,590	282-3,085	45-815	35-323	21-565	56-832	158-2,170	0.8-28
McKay Coal										
Average Area C	8	2,470	1,910	643	115	86	362	493	986	8
Average Rosebud Mine	42	2,606	2,295	1,147	195	161	279	531	1,296	12
Range Area C	8	957-3,730	616-2,650	64-1,370	15-247	6-183	34-748	391-554	149-1,560	2-16
Range Rosebud Mine	42	750-9,130	546-9,843	37-7,630	6-540	0.2-945	31-748	22-914	121-7,560	2-189
Sub-McKay										
Average Area C	2	2,335	1,900	1,008	154	152	232	341	1,068	7
Average Rosebud Mine	7	2,646	2,182	855	152	116	377	471	1,240	9
Range Area C	2	2,190-2,480	1,600-2,200	695-1,320	117-192	98-206	157-299	193-489	917-1,200	7-8
Range Rosebud Mine	7	1,330-4,140	946-3,210	211-1,740	47-265	16-263	120-995	273-554	35-1,990	2-14

APPENDIX B

TABLE 2

Chemical Data Showing Change in TDS Concentration with Time for Valley Fill Wells Suspected of Being Contaminated with Spoils Water

Well Number	Date	TDS Concentration mg/l	Date	TDS Concentration mg/l
S-05	9/25/73	5,050	7/20/77	5,783
	2/04/74	4,530	3/30/78	5,719
	6/06/74	4,710	10/31/79	6,000
	2/05/75	4,520	12/18/79	5,890
	6/04/75	5,557		
	10/07/76	5,771		
	11/18/76	5,794		

Well Number	Date	TDS Concentration mg/l	Date	TDS Concentration mg/l
S-13	9/25/73	3,650	1/12/76	3,710
	2/04/74	3,230	10/30/79	4,530
	6/06/74	3,290	12/18/79	4,440
	2/04/75	2,250		

Well Number	TDS Concentration in mg/l				
	1974	1975	1976	1979	1980
P-01	1,790	1,990	1,982	2,690	2,790
P-02	—	2,190	—	2,590	2,730
P-03	—	2,380	2,410	2,690	2,820
P-05	—	2,000	—	4,840	5,110

APPENDIX B

TABLE 3

Comparison of TDS for Wells WA-133 and WA-135 with other Valley Fill Wells in Cow Creek and Pony Creek Basins East of Northern Pacific Mined Area

Well Number	Date	TDS Concentration in mg/l	Location
WA 133	4/24/81	3,930	Cow Creek
WA 135	4/24/81	4,340	Cow Creek
WA 132	4/24/81	2,980	Cow Creek
WA 134	4/21/81	2,590	Cow Creek
WA 136	5/12/81	3,290	Cow Creek
WA 137	5/12/81	3,130	Cow Creek
WA 112	12/05/79	1,860	Pony Creek

APPENDIX B

TABLE 4

Chemical Data Showing Change in TDS Concentration with Time for McKay Wells S-04, S-08, and WM-127

Well Number	Date	TDS Concentration mg/l	Date	TDS Concentration mg/l
S-04	9/25/73	1,160	7/20/77	5,356
	6/06/74	1,340	3/30/78	9,843
	9/30/75	5,610	2/13/79	5,599
	1/14/76	3,870	8/14/79	6,544
	4/14/76	6,030	2/19/80	5,255
	6/23/76	10,182*		
	8/17/76	7,910	Average	5,725
	10/07/76	6,876		
	4/07/77	4,585		

* Sum of dissolved constituents

Well Number	Date	TDS in mg/l
S-08	9/25/73	2,860
	6/06/74	2,980
	3/30/78	2,960
	10/30/79	3,570
	12/18/79	3,590
WM-127	5/12/81	7,490
	8/15/81	7,420

APPENDIX B

TABLE 5

SURFACE WATER GAGING STATIONS, COLSTRIP AREA

Station	Owner	Location	Grid-East	Grid-North
CG-01		01N41E08ADAC	48,000.00	43,000.00
CG-02		01N41E02DDAD	64,800.00	45,600.00
CG-03		01N42E19DBCC	72,900.00	62,300.00
CG-04		02N41E33CABA	50,800.00	52,600.00
CG-05		02N41E33DDDD	54,200.00	50,400.00
SW-01	WECO	02N41E28AAD	54,200.00	59,400.00
SW-1A	WECO	02N41E27BCCC	54,700.00	58,200.00
SW-2A	WECO	02N42E31CADC	72,400.00	51,800.00
SW-09	WECO	02N40E33DABC	21,600.00	52,400.00
SW-10	WECO	01N41E07AAA	43,600.00	44,400.00
SW-11	WECO	01N40E11DAD	33,500.00	40,800.00
SW-12	WECO	02N41E16BBA	50,400.00	71,100.00
SW-13	WECO	01N40E07CCC	7,700.00	39,500.00
SW-14	WECO	01N41E03BBBB	54,700.00	50,100.00
SW-15		01N41E09BCAA	50,400.00	43,300.00
SW-17	MBMG	03N41E28CCD	50,300.00	87,800.00
SW-18	WECO	01N40E15BBC	22,900.00	38,300.00
SW-19	MBMG	02N41E34BDB	55,900.00	53,800.00
SW-20		01N41E08BACC	45,300.00	43,700.00
SW-21	MBMG	02N41E09BCB	49,500.00	74,900.00
SW-22	MBMG	02N41E28AABD	53,800.00	60,100.00
SW-23	MBMG	01N41E08ABB	47,100.00	44,600.00
SW-24	WECO	01N41E08ABA	47,600.00	44,700.00
SW-25	WECO	02N41E34CCC	55,500.00	50,700.00
SW-26	WECO	01N41E03ACCB	57,300.00	48,200.00
SW-27	WECO	01N41E03BBBB	54,700.00	49,900.00
SW-30		01N41E07ABCB	41,500.00	44,100.00
SW-35	WECO	01N40E11CCAA	74,400.00	50,800.00
SW-40		02N41E30CDAB	40,800.00	56,700.00
SW-45		02N40E34CBAC	23,700.00	52,300.00
SW-50		01N40E05ABCB	15,000.00	49,500.00
SW-55	WECO	01N40E11CAD		
SW-60	WECO	02N42E32CBDD	67,800.00	51,700.00
SW-61	WECO	01N40E10CDDC	24,900.00	39,500.00
SW-64	WECO	02N41E21DCA	53,000.00	62,000.00
SW-65	WECO	01N41E08AABD	48,400.00	44,400.00
SW-66	WECO	01N41E07ABCB	41,500.00	44,100.00
SW-67	WECO	01N41E03BBBC	54,700.00	49,800.00
SW-68	WECO	01N40E11DADD	33,500.00	40,800.00
SW-70		02N41E14DCA	63,300.00	66,900.00
SW-75		01N40E17BBBA	70,000.00	61,900.00

APPENDIX B

TABLE 6

LIST OF TOTAL DISSOLVED SOLIDS FOR SAMPLES COLLECTED BY THE U.S.G.S. AT SEVERAL SITES IN THE ARMELLS AND ROSEBUD CREEK BASINS

Stream Discharges for East Fork Armells near Colstrip at Time of Sample Collection is Presented

	Instantaneous Discharge in Cubic Feet Per Second	EF Armells Near Colstrip	Armells Near Forsyth	WF Armells Near Forsyth	Rosebud Near Colstrip	Rosebud Above Pony Creek	Cow Creek Near Colstrip
			(Total Dissolved Solids in Milligrams Per Liter)				
Oct.			2,240		782	832	
Nov.			939	2,510	708	794	
Dec.			3,010	5,660	974	1,030	
Jan. 1975	169	178	3,830	4,520	940	959	
Feb.			1,890	3,810	904	774	
March	21	719	379	383	198	214	
April	2.5	4,110	3,380	4,550	1,000	1,150	
May	6.4	3,310	2,970	3,270	703	790	
June	2.6	3,930	4,030	4,450	632	693	
July			3,410	4,550	669	686	
Aug.			3,840		707	728	
Sept.	2.7	2,060	2,880		709	796	
Oct.	3.7	2,000	3,170	5,710	771	815	
Nov.	1.4	3,370	2,560	4,800	756	899	
Dec.	1.7	3,720	4,100		857	963	
Jan. 1976	1.1	3,690	4,080		887	910	
Feb.	4.3	2,970	2,580	2,730	830	1,040	
March	2.3	3,150	2,780	4,840	738	811	
April	2.4	3,130	4,210	4,850	857	912	
May	5.4	2,860	2,950	4,660	715	830	
June	1.4	3,490	4,190	5,030	728	801	
July	1.6	3,230	3,300		659	627	
Aug.			2,370		758	841	
Sept.			2,330		810	971	
Oct.	1.2	3,890	3,300		839	895	
Nov.	1.5	3,480	3,730		943	1,000	
Dec.	1.4	4,090	4,310		918	996	

APPENDIX B

TABLE 6 (Continued)

	Instantaneous Discharge in Cubic Feet Per Second	EF Armells Near Colstrip	Armells Near Forsyth	WF Armells Near Forsyth	Rosebud Near Colstrip	Rosebud Above Pony Creek	Cow Creek Near Colstrip
		(Total Dissolved Solids in Milligrams Per Liter)					
Jan. 1977	0.73	4,320	3,680		870	940	
Feb.	4.2	3,030	992	1,570	869	704	
March	.22	4,170	3,910	5,540	811	871	
April	.70	4,580	3,520	5,210	555	588	
May	2.0	4,130	2,070	4,450	646	658	
June	.01			2,830	646	700	
July			2,360		741	801	
Aug.					802	897	
Sept.	.51	4,430			895	981	
Oct.	.79	3,890			799		
Nov.						912	
Dec.	.86	4,180			888		
Jan. 1978							
Feb.	.75	4,020			871		
March	1.9	3,850	418		878		
April	2.3	4,000	4,470		782		
May	8.9	2,970	1,680		754		
June	2.5	3,850	4,100		855		
July	.28	3,850					
Aug.			2,710				
Sept.			2,290		843		
Oct.	.51	4,260	4,470		857		
Nov.							
Dec.	1.9	3,950	4,160		953		
Jan. 1979							
Feb.					938		
March	56	985	586				
April	4.5	3,180	3,170		914		
May	3.0	3,880	4,200		753		
June	1.1		4,520		763		
July			2,860		802		

APPENDIX B

TABLE 6 (Concluded)

	Instantaneous Discharge in Cubic Feet Per Second	EF Armells Near Colstrip	Armells Near Forsyth	WF Armells Near Forsyth	Rosebud Near Colstrip	Rosebud Above Pony Creek	Cow Creek Near Colstrip
		(Total Dissolved Solids in Milligrams Per Liter)					
Aug.			2,360		813		
Sept.			2,070		916		
Oct.	.83	4,260	3,570		911		7,900
Nov.							5,495
Dec.	.46	3,880	4,010		936		
Jan. 1980	.49	4,700	5,050		955		
Feb.	1.3	3,580	4,200		924		5,420
March	2.3	3,380	3,010		690		3,110
April	.80	3,970	3,600		806		4,470
May	E.04	4,560	3,570		949		4,610
June	4.1	2,530	3,890		814		3,930
July							
Aug.							
Sept.	.51		2,670				
Oct.	E.05	4,390	1,030		1,010		5,180
Nov.	.28	5,040	1,640				5,510
Dec.					1,000		
Jan. 1981	.69	4,170	4,000		1,090		4,740
Feb.	1.5	3,700	1,860		768		3,860
March	1.1	4,240	3,190		1,150		4,480
April	.84	3,740	3,350		1,010		4,490
May	7.8	1,130	3,360		971		3,050
June							
July					1,050		
Aug.			1,830		1,080		
	MEAN:	3,525	3,031	4,155	833	833	4,732

EF - East Fork
WF - West Fork
E - Estimate

APPENDIX B

TABLE 7

Chemical Data for Surface Water Stations
In Vicinity of Area C, Block I
On East Fork Armells and Stocker Creek

Date	SW-09 TDS Concentration	Date	SW-65 TDS Concentration
7-25-73	2740	5-12-81	4580
6-08-79	3490	5-21-81	3620
8-06-79	3490		
11-29-76	*5180-4880		
6-15-80	*4240-3950		
9-17-80	*5180-4460		
2-03-81	2910		
3-11-81	2690		

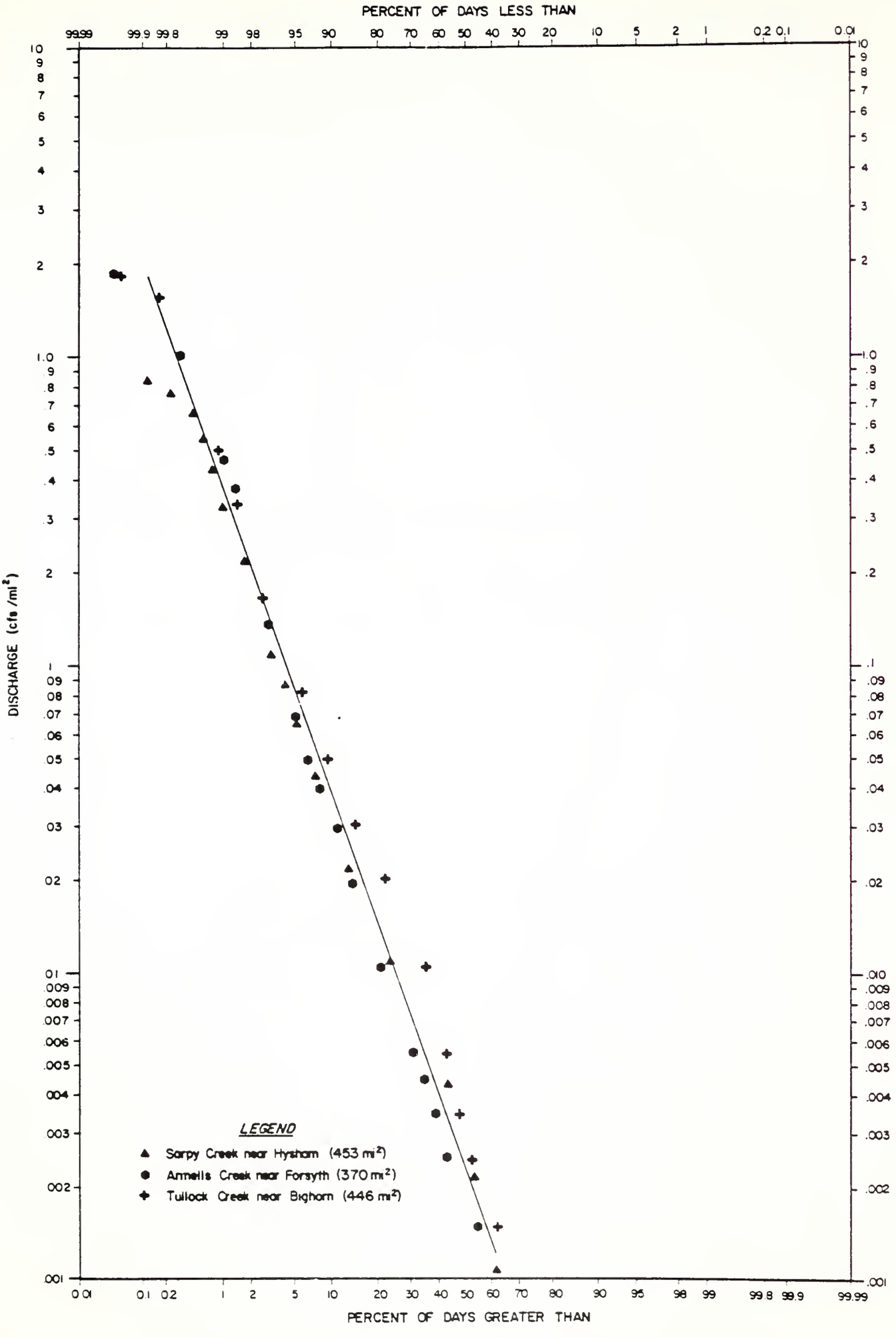
*Duplicate sample collected

TABLE 8

Chemical Data for Springs
In Vicinity of Area C, Block I

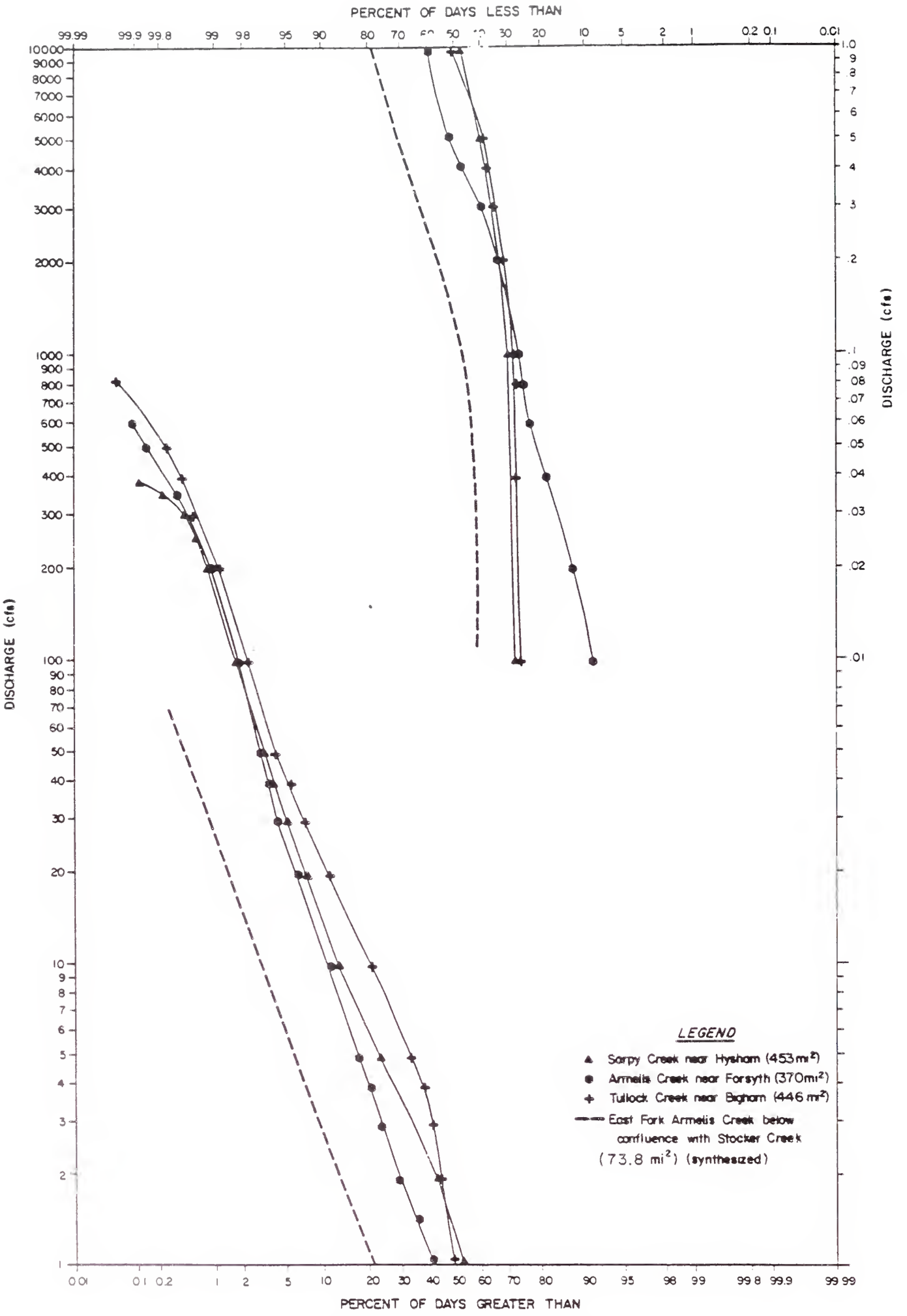
CONCENTRATIONS OF MAJOR CONSTITUENTS FOR SPRINGS
(In mg/l)

	TDS	Ca	Mg	Na	HCO_3	SO_4	Cl	N
SP-01	5,310	580	520	220	900	3,090	98	2.10
SP-02	470	77	54	4	360	65	11	12.38
SP-03	4,930	300	430	490	570	2,970	21	0.04
SP-04	3,240	240	350	190	520	1,901	9	0.11
SP-05	5,160	290	610	240	630	3,080	27	0.02



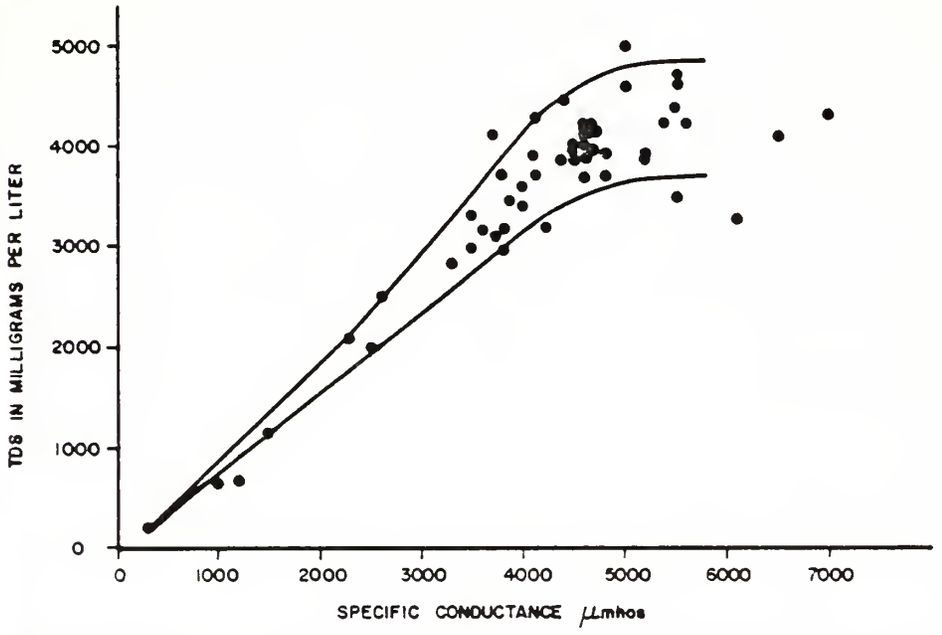
PROBABILITY OF FLOW OCCURRENCE PER SQUARE MILE OF DRAINAGE AREA

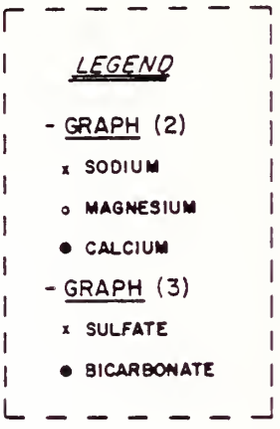
APPENDIX B FIGURE 1



PROBABILITY OF FLOW OCCURRENCE IN DAYS

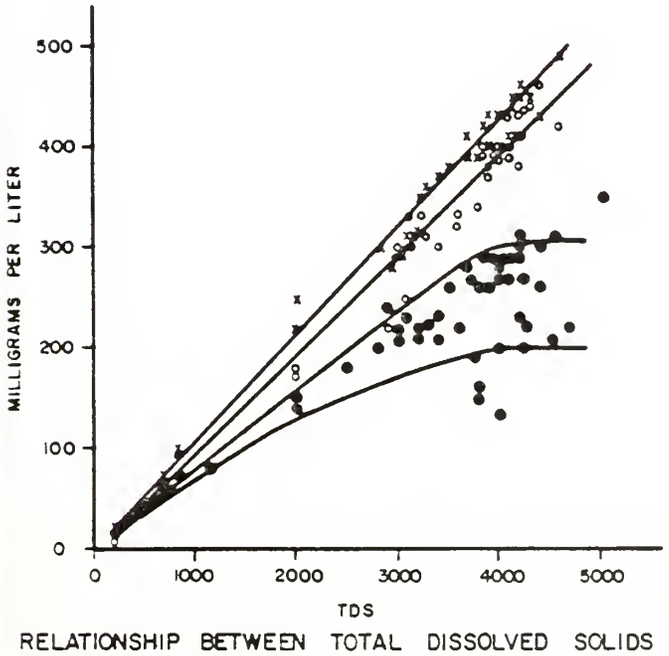
APPENDIX B FIGURE 2





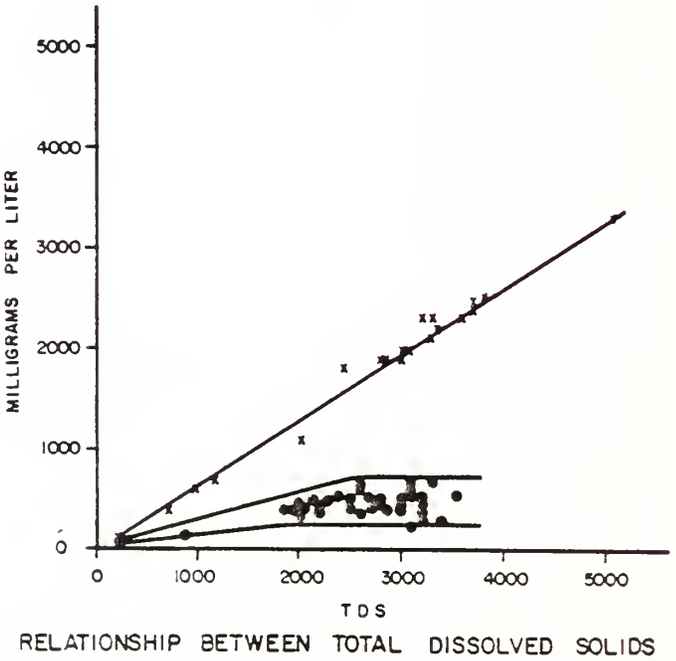
RELATIONSHIP OF SPECIFIC CONDUCTANCE TO TOTAL DISSOLVED SOLIDS FOR EAST FORK ARMELLS CREEK AT USGS STATION NEAR COLSTRIP, MONTANA

(1)



RELATIONSHIP BETWEEN TOTAL DISSOLVED SOLIDS AND SODIUM, MAGNESIUM, AND CALCIUM FOR EAST FORK ARMELLS CREEK AT USGS STATION NEAR COLSTRIP, MONTANA

(2)



RELATIONSHIP BETWEEN TOTAL DISSOLVED SOLIDS WITH SULFATE AND BICARBONATE FOR EAST FORK ARMELLS CREEK AT USGS STATION NEAR COLSTRIP, MONTANA

(3)

APPENDIX B
FIGURE 3 RELATIONSHIPS BETWEEN SELECTED CHEMICAL CONSTITUENTS FOR EAST FORK ARMELLS CREEK AT USGS STATION NEAR COLSTRIP, MONTANA

APPENDIX F

TABLE 1

SOIL CHARACTERISTICS OF MAPPING UNITS BY GENERAL SOIL GROUPS

ALLUVIAL LOAMY AND CLAYEY SOILS

Soil Mapping Unit	Slope (%)	Dryland Capability	Acreage to be Disturbed	Salvage Depth Topsoil	Salvage Depth Subsoil	Limitations
16A Kremlin loam	0-2	3e	71.3	1.0'	3.5'	Occassional high salts in subsoil
16C Kremlin loam	2-8	3e	108.0	1.0'	3.5'	Occassional high salts in subsoil
37A Lonna silt loam	0-2	3c	110.7	1.0'	3.0'	Occassional high clay High salts in subsoil
37C Lonna silt loam	2-8	3e	126.0	1.0'	3.0'	Occassional high clay High salts in subsoil
37D Lonna silt loam	8-15	4e	10.3	1.0'	3.0'	Occassional high clay High salts in subsoil
49A Yamac loam	0-2	3e	11.7	1.0'	2.5'	Occassional high salts in subsoil
49C Yamac loam	2-8	3e	108.7	1.0'	2.5'	Occassional high salts in subsoil
49D Yamac loam	8-5	4e	42.1	1.0'	2.5'	Occassional high salts in subsoil
59C Kobar silty clay loam	2-8	3e	4.6	0.5'	2.5'	Moderate to high clay, high salts in subsoil
72B Vanstel silt loam	0-4	3e	23.6	1.0'	1.0'	Occassional high clay
72D Vanstel silt loam	4-8	3e	0.7	1.0'	1.0'	Occassional high salts at surface
92C Delpoint loam	4-8	3e	9.4	0.5'	2.5'	High clay, occassional high salts
92D Delpoint loam	8-20	4e	65.9	0.5'	2.5'	High clay, occassional high salts
311 Havre loam	0-4	3w	0.9	1.0'	0.5'	Occassional high salts
7E Ustic Torriorthents	0-20*	3w-4e	15.9	1.0'	2.5'	Occassional high salts
			709.8	(Represents 44% of area to be disturbed)		

* Reflects slopes occurring in Area C.

APPENDIX F

TABLE 1 (Continued)

SANDY RESIDUAL SOILS

Soil Mapping Unit	Slope (%)	Dryland Capability	Acreage to be Disturbed	Salvage Depth Topsoil	Salvage Depth Subsoil	Limitations
13C Busby fine sandy loam	2-8	4e	301.8	0.5	2.0	Excess sand
13D Busby fine sandy loam	8-15	4e	238.6	0.5	2.0	Excess sand
23C Cooers loam	2-8	3e	59.5	1.0	2.5	Excess sand
131E Busby-Yetull-Rock Outcrop Complex	8-25	6e	65.3	0.5	1.5	Excess sand, depth to rock
132E Busby-Reidel Complex	8-25	6e	43.6	0.5	1.5	Excess sand, depth to rock
183E Busby-Rock Outcrop Complex	8-25	6e	1.3	0.5	1.0	Excess sand, depth to rock
			710.1	(Represents 44% of area to be disturbed)		

SCORIA SOILS

Soil Mapping Unit	Slope (%)	Dryland Capability	Acreage to be Disturbed	Salvage Depth Topsoil	Salvage Depth Subsoil	Limitations
121E Birney-Kirby Channery loams	4-25	6e	50.9	0.5	1.0	Depth to rock
122D Birney-Cooers-Kirby Complex	2-15	6s	56.6	0.5	1.5	Depth to rock
123E Birney-Kirby Channery loams, moist	15-25	6e	10.5	0.5	1.0	Depth to rock
125E Birney-Kirby-Cabbart Complex	15-25	6e	15.2	0.5	1.5	Depth to rock
127F Birney-Kirby-Cabbart Complex	25-70	7e	4.8	0.5	1.5	Depth to rock, slope limits salvaging operations
			138.0	(Represents 8% of area to be disturbed)		

APPENDIX F

TABLE 1 (Continued)

UNBAKED SHALE AND SILTSTONE SOILS

Soil Mapping Unit	Slope (%)	Dryland Capability	Acreage to be Disturbed	Salvage Depth Topsoil	Salvage Depth Subsoil	Limitations
84D Cabbart loam	4-15	6e	7.1	0.5'	1.0'	Depth to rock, high clay, high salts
184F Cabbart-Yawdim-Rock Outcrop Complex	15-70	7e	22.9	0.5'	0.0'	Depth to rock, high clay
188E Delpoint-Cabbart loams	15-25	6e	2.7	0.5'	0.5'	Depth to rock, high clay, high salts
493E Yamac-Cabbart loams	8-25	6e	5.7	0.5'	1.0'	Depth to rock, high clay, high salts
741C Delpoint-Rentsac loams	2-8	4e	30.5	0.5'	1.0'	Depth to rock, high clay
			68.9	(Represents 4% of area to be disturbed)		

APPENDIX G

TABLE I

RANGE PRODUCTION, VEGETATIVE PRODUCTION,
AND INITIAL STOCKING RATES FOR NATIVE
VEGETATIVE COMMUNITIES IN
AREA C, BLOCK I

General Vegetative Type[a]	Sub-type	Range Condition Class[b]	Present Initial Stocking Rate aum/ac.[c]	Present Total Annual Veg. Production lbs./acre[b]	Potential Veg. Production lbs./acre[c]	Potential Initial Stocking Rate aum/ac.[c]
Grassland	loamy, silty soils	Fair	.15	564	1050-2200	.45
	sandy soils	Fair	.15	564	1000-2300	.45
Sagebrush-Shrubland	big sagebrush	Fair	.15	692	1050-2200	.45
	silver sagebrush	Fair	.15	1000	1050-2200	.45
	"gumbo knob"	Poor	.05	306	500-1100	.23
Conifer-Shrubland	skunkbush sumac	Good	.25	1025	900-2400	.45
	ponderosa pine	Good	.20	356	500-1200	.23

[a] Shown on Figure II-11

[b] Source: 1979 Vegetation Report for mining Area C for Western Energy, ECON, Inc.

[c] Source: SCS-Montana Technical Guide, Section II-E-8, current figures (3/82) for Miles City field office.

Initial stocking rates are intended to be used as a guide for grazing management. Actual stocking rates will vary depending upon the class of livestock, season of use, and characteristics of the site.

APPENDIX G

TABLE 2

PROPOSED REVEGETATION APPROACH
AREA C, BLOCK I

PHASE I - SUPPLEMENTAL GRASS, FORBS, AND SHRUB MIXTURE

This seed mixture will be broadcast onto prepared seedbeds in all reclaimed areas during the first optimal seeding period following soil placement.

Common Name/Scientific Name	Percent of Mix (PLS)
Side-oats grama/Bouteloua curtipendula	28
Needle-and-Thread/Stipa comata	15
Indian ricegrass/Oryzopsis hymenoides	10
Fourwing saltbush/Atriplex canescens	5
Winterfat/Ceratoides lanata	10
Blue grama/Bouteloua gracilis	10
Lewis flax/Linum lewisii	5
Prairie coneflower/Ratibida columnifera	5
Western yarrow/Achillea millefoluim lanulosa	5
Purple prairie clover/Petalostemon purpureum	2.5
White prairie clover/Petalostemon candidum	2.5
Cicer milkvetch (Lutana)/Astragalus cicer	1
Sainfoin (ESKE)/Onobrychis viciaefolia	1

Seeding rates 13 lbs./acre of pure live seed (PLS), with an additional 5 lbs. PLS/acre of sterile wintergraze.

APPENDIX G

TABLE 2 (Continued)

PHASE II - REVEGETATION AREA SEED MIXTURES

These mixtures will be drill seeded one to three years after the first phase supplemental mixture is planted. Seeding rates will be 20 pounds of pure live seed (PLS) per acre, with an additional five pounds (PLS) of the sterile hydrid wintergraze included to increase cover. Areas have been delineated based upon topographic position on the post-mined topography.

Lowland/Drainage Seed Mixture - 84 acres

Common Name/Scientific Name	Percent of Mix (PLS)
Rosana Western Wheatgrass/*Agropyron smithii*	30
Slender Wheatgrass/*A. trachycaulum*	20
Thickspike Wheatgrass/*A. dasystachyum*	10
Mountain brome/*Bromus marginatus*	10
Kentucky bluegrass/*Poa pratensis*	10
Canada bluegrass/*P. compressa*	10
Canada wildrye/*Elymus canadensis*	10

Uplands Grass Mixture - 821 acres

Common Name/Scientific Name	Percent of Mix (PLS)
Rosana Western wheatgrass/*Agropyron smithii*	40
Critana thickspike wheatgrass/*A. dasystachyum*	25
Slender wheatgrass/*A. trachycaulum*	5
Green needlegrass/*Stipa viridula*	30

Of the areas planted with this mix, tubeling shrubs grown in a greenhouse from locally collected seed will be planted on the following acreages:

21 acres - Big sagebrush/*Artemisia tridentata*

18 acres - Silver sagebrush/*Artemisia cana*

11 acres - Skunkbush sumac/*Rhus trilobata*

1 acre - Rubber rabbitbush/*Chrysothamnus nauseous*

1 acre - Skunkbush sumac and Rubber rabbitbrush

APPENDIX G

TABLE 2 (Continued)

Steep Uplands Grass Mixture - 600 acres

Common Name/Scientific Name	Percent of Mix (PLS)
Green needlegrass/*Stipa viridula*	50
Rosana western wheatgrass/*Agropyron smithii*	15
Critana thickspike wheatgrass/*A. dasystachyum*	30
Slender wheatgrass/*A. trachycaulum*	5

Of the areas planted with the mix, tubeling shrubs will be planted on the following acreages:

63 acres - Big Sagebrush

41 acres - Skunkbush sumac

2 acres - Rubber rabbitbrush

Conifer Zone Grass Mixture - 61 acres

Common Name/Scientific Name	Percent of Mix (PLS)
Green needlegrass/*Stipa viridula*	40
Side-oats grama/*Bouteloua curtipendula*	40
Indian ricegrass/*Oryzopsis hymenoides*	10
Rosana western wheatgrass/*Agropyron smithii*	5
Critana thickspike wheatgrass/*A. dasystachyum*	5

Of the areas planted with the mix, nine acres will be planted with tubelings of skunkbush sumac.

In any of the areas in which sandy soils may occur, e.g., the Uplands, Steep Uplands, and Conifer Zone, an additional "patch seeding" approach will be used. Sandy soil materials of one acre or less in size will be seeded with the following mixture of warm season grasses at a rate of 40 lbs./acre PLS:

Big bluestem/*Andropogon gerardii*

Sand bluestem/*A. hallii*

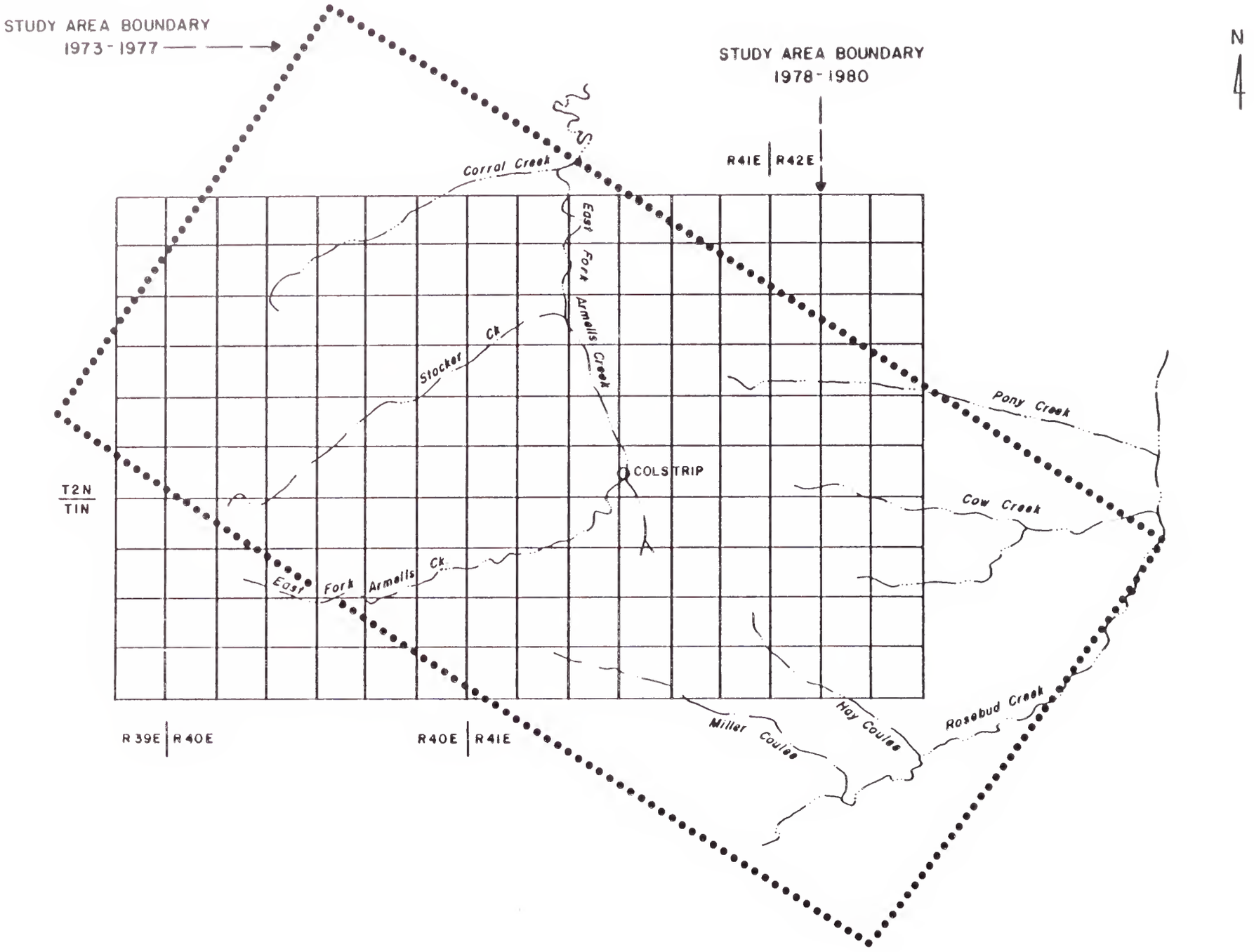
Little bluesteam/*Schizachyrium scoparium*

Prairie sandreed/*Calamovilfa longifolia*

APPENDIX G

TABLE 2 (Continued)

Additional shrubs and trees will be transplanted by utilizing a tree spade and transplanting mature stock from potentially disturbed areas onto regraded areas. Any of the numerous shrub and tree species occurring in Area C, Block I may be handled in this way.



APPENDIX H

FIGURE 1 MAP OF ROSEBUD MINE WILDLIFE STUDY AREA

APPENDIX H

TABLE 1

SUMMARY OF PRONGHORN ANTELOPE AERIAL SURVEYS AND RESULTS
WILDLIFE STUDY AREA 1974 - 1980

Year	Number of Flights	Total Air Hours	Obser-vations Per Hour	Fawns Per 100 Does	Percent Herd Composition		
					Male	Female	Young
1974	14	24.1	37.5	40	25	54	21
1975	24	37.9	29.6	20	20	67	13
1976	23	41.7	21.7	18	18	69	13
1977	20	31.1	25.8	31	12	67	21
1978*	23	31.5	25.9	34	18	61	21
1979*	17	31.5	15.6	49	15	57	28
1980*	21	33.2	24.1	59	12	55	33

* Study area was reduced in 1978 from 200 sq. mi. to 160 sq. mi., of which approximately 80 percent was included in the original 200 sq. mi. study area.

APPENDIX H

TABLE 2

SUMMARY OF MULE DEER AERIAL SURVEYS AND RESULTS

WILDLIFE STUDY AREA

Year	Number of Flights	Total Air Hours	Observations Per Hour	Fawns Per 100 Does	Percent Herd Composition		
					Antlered	Antlerless	Young
1974	10	24.1	31.9	68	13	52	35
1975	23	37.9	22.4	70	14	50	36
1976	23	41.7	21.1	62	12	54	34
1977	19	31.1	19.2	57	11	57	32
1978*	22	31.5	12.7	64	15	52	33
1979*	24	31.5	14.6	78	12	49	39
1980*	30	33.2	15.2	56	15	54	30

* Study area was reduced in 1978 from 200 sq. mi. to 160 sq. mi., of which approximately 80 percent was included in the original 200 sq. mi. study area.

APPENDIX H

TABLE 3

MAMMALS EXPECTED IN SOUTHEASTERN MONTANA*

Common Name (Scientific Name)	Colstrip[1]	Special Concern[2]	Thompson[3]
Insectivora:			
Masked shrew (Sorex cinereus)	X		
Hayden shrew (Sorex haydeni)			X
Preble's shrew (Sorex preblei)			X
Merriam's shrew (Sorex merriami)		X	
Chiroptera:			
Little brown myotis (Myotis lucifugus)	X		
Long-eared myotis (Myotis evotis)			X
Small-footed myotis (Myotis leibii)	X		X
Long-legged myotis (Myotis volans)			
Silver-haired bat (Lasionycteris noctivagans)			
Big brown bat (Eptesicus fuscus)	X		X
Hoary bat (Lasiurus cinereus)			X
Townsend's big-eared bat (Plecotus townsendii)		X	X
Lagomorpha:			
Nuttall's cottontail (Sylvilagus nuttallii)	X		
Desert cottontail (Sylvilagus audubonii)	X		X
Snowshoe hare (Lepus americanus)			
White-tailed jackrabbit (Lepus townsendii)	X		X
Rodentia:			
Least chipmunk (Eutamias minimus)	X		X
Yellow-bellied marmot (Marmota flaviventris)	X		X
Richardson's ground squirrel (Spermophilus richardsonii)	X		
Thirteen-lined ground squirrel (Spermophilus tridecemlineatus)	X		X

* Nomenclature follows Jones, et al, 1979; distribution information from Hall, 1981; Burt and Grossenheider, 1964; Flath, 1981; and Thompson, 1982.

1 Denotes species seen during the Rosebud Mine Wildlife Studies (Ecological Consulting Service, 1972, 1973, 1974, 1975; ECON, 1976a, 1977a, 1978, 1979; Western Energy, 1980).

2 Denotes species listed by Flath, 1981.

3 Denotes species listed as known from latilongs 33 or 43 by Thompson (1982).

APPENDIX H

TABLE 3 (Continued)

Common Name (Scientific Name)	Colstrip[1]	Special Concern[2]	Thompson[3]
Black-tailed prairie dog (Cynomys ludovicianus)	X	X	X
Fox squirrel (Sciurus niger)			X
Red squirrel (Tamiasciurus hudsonicus)			X
Northern pocket gopher (Thomomys talpoides)	X		X
Olive-backed pocket mouse (Perognathus fasciatus)			X
Ord's kangaroo rat (Dipodomys ordii)	X		X
Beaver (Castor canadensis)	X		X
Western harvest mouse (Reithrodontomys megalotis)	X		X
Deer mouse (Peromyscus maniculatus)	X		X
White-footed mouse (Peromyscus leucopus)	X		X
Northern grasshopper mouse (Onchomys leucogaster)	X		X
Bushy-tailed wood rat (Neotoma cinerea)			X
Meadow vole (Microtus pennsylvanicus)	X		X
Long-tailed vole (Microtus longicaudus)			X
Prairie vole (Microtus ochrogaster)	X		X
Sagebrush vole (Lagurus curtatus)			
Muskrat (Ondatra zibethicus)	X		X
House mouse (Mus musculus)	X		X
Meadow-jumping mouse (Zapus hudsonius)	X		X
Western jumping mouse (Zapus princeps)			
Porcupine (Erethizon dorsatum)	X		X
Carnivora:			
Coyote (Canis latrans)	X		X
Red fox (Vulpes vulpes)	X		X
Swift fox (Vulpes velox)		X	X
Black bear (Ursus americanus)			X
Raccoon (Procyon lotor)	X		X
Ermine (Mustela erminea)			X
Long-tailed weasel (Mustela frenata)	X		X
Black-footed ferret (Mustela nigripes)**		X	
Mink (Mustela vison)			X
Badger (Taxidea taxus)	X		X

** Endangered species (Federal Register, 1980)

APPENDIX H

TABLE 3 (Continued)

Common Name (Scientific Name)	Colstrip[1]	Special Concern[2]	Thompson[3]
Striped skunk (Mephitis mephitis)	X		X
River otter (Lutra canadensis)			X
Mountain lion (Felis concolor)			X
Bobcat (Felis rufus)	X		X
Artiodactyla:			
Elk (Cervus elaphus)	X		X
Mule deer (Odocoileus hemionus)	X		X
White-tailed deer (Odocoileus virginianus)	X		X
Pronghorn (Antilocapra americana)	X		X
Mountain sheep (Ovis canadensis)			X

APPENDIX H

TABLE 4

BIRDS EXPECTED IN SOUTHEASTERN MONTANA*

Common Name (Scientific Name)	Colstrip[1]	Special Concern[2]	Skaar[3]
Gaviiformes:			
Common loon (Gavia immer)	X		X
Podicipediformes:			
Horned grebe (Podiceps auritus)	X		X
Eared grebe (Podiceps caspicus)	X		X
Western grebe (Aechmophorus occidentalis)	X		X
Pied-billed grebe (Podilymbus podiceps)	X		X
Pelecaniformes:			
White pelican (Pelecanus erythrorhynchos)	X		X
Double-crested cormorant (Phalacrocorax auritus)			X
Anseriformes:			
Whistling swan (Olor columbianus)			
Canada goose (Branta canadensis)	X		X
Snow goose (Chen hyperborea)			
Mallard (Anas platyrhynchos)	X		X
Black duck (Anas rubripes)			X
Gadwall (Anas strepera)	X		X
Pintail (Anas acuta)	X		X
Green-winged teal (Anas carolinensis)	X		X
Blue-winged teal (Anas discors)	X		X
Cinnamon teal (Anas cyanoptera)	X		X
American widgeon (Mareca americana)	X		X
Shoveler (Spatula clypeata)	X		X
Wood duck (Aix sponsa)			X
Redhead (Aythya americana)	X		X
Ring-necked duck (Aythya collaris)	X		X
Canvasback (Aythya valisineria)	X		X
Lesser scaup (Aythya affinis)	X		X
Common goldeneye (Bucephala clangula)	X		X
Bufflehead (Bucephala albeola)	X		
Ruddy duck (Oxyura jamaicensis)	X		X
Common merganser (Mergus merganser)			X

* Distribution information from Robbins et al., 1966.

1 Denotes species seen during Rosebud Mine Wildlife Studies.

2 Denotes species listed by Flath, 1981.

3 Denotes species listed by Skaar, 1975, as present in latilongs 34 or 43.

APPENDIX H

TABLE 4 (Continued)

Common Name (Scientific Name)	Colstrip	Special Concern	Skaar
Falconiformes:			
Turkey vulture (Cathartes aura)			X
Goshawk (Accipiter gentilis)		X	
Sharp-shinned hawk (Accipiter striatus)			X
Cooper's hawk (Accipiter cooperii)	X	X	X
Red-tailed hawk (Buteo jamaicensis)	X		X
Swainson's hawk (Buteo swainsoni)	X		X
Rough-legged hawk (Buteo lagopus)	X		X
Ferruginous hawk (Buteo regalis)	X	X	X
Golden eagle (Aquila chrysaetos)	X	X	X
Bald eagle (Haliaeetus leucocephalus)**	X	X	X
Northern harrier (Circus cyaneus)	X		X
Osprey (Pandion haliaetus)		X	X
Prairie falcon (Falco mexicanus)	X	X	X
Peregrine falcon (Falco peregrinus)**		X	
Merlin (Falco columbarius)	X	X	
American kestrel (Falco sparverius)	X		X
Galliformes:			
Ruffed grouse (Bonasa umbellus)			X
Sharp-tailed grouse (Pedioecetes phasianellus)	X		X
Sage grouse (Centrocercus urophasianus)	X		X
Ring-necked pheasant (Phasianus colchicus)	X		X
Chukar (Alectoris graeca)			X
Hungarian (Gray) Partridge (Perdix perdix)	X		X
Turkey (Meleagris gallopavo)	X		X
Ciconiformes:			
Great blue heron (Ardea herodias)	X		X
American bittern (Botaurus lentiginosus)			X
Gruiformes:			
Whooping crane (Grus americana)**			X
Sandhill crane (Grus canadensis)			X
Virginia rail (Rallus limicola)			
Sora (Porzana carolina)			X
American coot (Fulica americana)	X		X
Charadriiformes:			
Killdeer (Charadrius vociferus)	X		X
Mountain plover (Eupoda montana)		X	X
Black-bellied plover (Squatarola squatarola)			
Common snipe (Capella gallinago)	X		X

** Endangered species (Federal Register, 1980)

APPENDIX H

TABLE 4 (Continued)

Common Name (Scientific Name)	Colstrip	Special Concern	Skaar
Long-billed curlew (Numenius americanus)		X	X
Upland plover (Bartramia longicauda)	X		X
Spotted sandpiper (Actitis macularia)	X		X
Solitary sandpiper (Tringa solitaria)	X		X
Willet (Catoptrophorus semipalmatus)	X		X
Greater yellowlegs (Totanus melanoleucus)	X		X
Lesser yellowlegs (Totanus flavipes)			X
Least sandpiper (Erolia minutilla)			X
Long-billed dowitcher (Limnodromus scolopaceus)	X		X
Semipalmated sandpiper (Calidris pusilla)			X
Western sandpiper (Erunetes mauri)			X
Marbled godwit (Limosa fedoa)			
American avocet (Recurvirostra americana)			X
Wilson's phalarope (Steganopus tricolor)	X		X
Northern phalarope (Lobipes lobatus)			X
Herring gull (Larus argentatus)			X
California gull (Larus californicus)			X
Ring-billed gull (Larus delawarensis)	X		X
Franklin's gull (Larus pipixcan)			X
Common tern (Sterna hirundo)	X		
Black tern (Chlidonias niger)	X		
Columbiformes:			
Rock dove (Columba livia)			X
Mourning dove (Zenaida macroura)	X		X
Cuculiformes:			
Yellow-billed cuckoo (Coccyzus americanus)			X
Black-billed cuckoo (Coccyzus erythropthalmus)	X		X
Strigiformes:			
Barn owl (Tyto alba)			X
Screech owl (Otus asio)			
Great horned owl (Bubo virginianus)	X		X
Pygmy owl (Glaucidium gnoma)		X	
Burrowing owl (Athene cunicularia)	X	X	
Barred owl (Strix varia)		X	
Long-eared owl (Asio otus)	X	X	
Short-eared owl (Asio flammeus)	X		X
Saw-whet owl (Aegolius acadicus)		X	X

APPENDIX H

TABLE 4 (Continued)

Common Name (Scientific Name)	Colstrip	Special Concern	Skaar
Caprimulgiformes:			
Poor-will (Phalaenoptilus nuttallii)			X
Common nighthawk (Chordeiles minor)	X		X
Apodiformes:			
Chimney swift (Chaetura pelagica)			X
White-throated swift (Aeronautes saxatalis)	X		X
Coraciiformes:			
Belted kingfisher (Megaceryle alcyon)	X		X
Piciformes:			
Common flicker (Colaptes auratus)	X		X
Red-headed woodpecker (Melanerpes erythrocephalus)	X		X
Lewis' woodpecker (Asyndesmus lewis)			X
Yellow-bellied sapsucker (Sphyrapicus varius)			
Hairy woodpecker (Dendrocopos villosus)			X
Downy woodpecker (Dendrocopos pubescens)	X		X
Black-backed three-toed woodpecker (Picoides arcticus)			X
Passeriformes:			
Eastern kingbird (Tyrannus tyrannus)	X		X
Western kingbird (Tyrannus verticalis)	X		X
Cassin's kingbird (Tyrannus vociferans)			X
Say's phoebe (Sayornis saya)	X		X
Least flycatcher (Empidonax minimus)			X
Dusky flycatcher (Empidonax oberholseri)	X		X
Western wood pewee (Contopus sordidulus)	X		X
Olive-sided flycatcher (Nuttalornis borealis)			?
Horned lark (Eremophila alpestris)	X		X
Violet-green swallow (Tachycineta thalassina)	X		X
Tree swallow (Iridoprocne bicolor)			X
Bank swallow (Riparia riparia)	X		X
Rough-winged swallow (Stelgidopteryx ruficollis)	X		X
Barn swallow (Hirundo rustica)	X		X
Cliff swallow (Petrochelidon pyrrhonota)	X		X
Purple martin (Progne subis)	X		X
Blue jay (Cyanocitta cristata)			X
Steller's jay (Cyanocitta stelleri)			
Black-billed magpie (Pica pica)	X		X

APPENDIX H

TABLE 4 (Continued)

Common Name (Scientific Name)	Colstrip	Special Concern	Skaar
Common raven (Corvus corax)			X
Common crow (Corvus brachyrhynchos)	X		X
Pinyon jay (Gymnorhinus cyanocephala)	X		X
Clark's nutcracker (Nucifraga columbiana)			
Black-capped chickadee (Parus atricapillus)	X		X
White-breasted nuthatch (Sitta carolinensis)	X		X
Red-breasted nuthatch (Sitta canadensis)	X		
Brown creeper (Certhia familiaris)			X
Dipper (Cinclus mexicanus)			
House wren (Troglodytes aedon)	X		X
Long-billed marsh wren (Telmatodytes palustris)			X
Canyon wren (Catherpes mexicanus)			X
Rock wren (Salpinctes obsoletus)	X		X
Mockingbird (Mimus polyglottos)	X		
Catbird (Dumetella carolinensis)	X		X
Brown thrasher (Toxostoma rufum)	X		X
Sage thrasher (Oreoscoptes montanus)			X
American robin (Turdus migratorius)	X		X
Swainson's thrush (Catharus ustulatus)			X
Gray-cheeked thrush (Catharus minimus)			X
Veery (Catharus fuscescens)			X
Townsend's solitaire (Myadestes townsendi)	X		X
Eastern bluebird (Sialia sialis)	X	X	X
Western bluebird (Sialia mexicana)	X	X	?
Mountain bluebird (Sialia currucoides)	X		X
Golden-crowned kinglet (Regulus satrapa)			
Ruby-crowned kinglet (Regulus calendula)			
Water pipit (Anthus spinoletta)			
Sprague's pipit (Anthus spragueii)			
Bohemian waxwing (Bombycilla garrula)	X		X
Cedar waxwing (Bombycilla cedrorum)	X		X
Northern shrike (Lanius excubitor)	X		X
Loggerhead shrike (Lanius ludovicianus)	X		X
Starling (Sturnus vulgaris)	X		X
Solitary vireo (Vireo solitarius)			X
Red-eyed vireo (Vireo olivaceus)	X		X
Warbling vireo (Vireo gilvus)			X
Black and white warbler (Mniotilta varia)			X
Orange-crowned warbler (Vermivora celata)			X
Yellow warbler (Dendroica petechia)	X		X
Yellow-rumped warbler (Dendroica auduboni)			X
Ovenbird (Seiurus aurocapillus)			X
Northern waterthrush (Seiurus novaboracensis)			X
Yellowthroat (Geothlypis trichas)	X		X

APPENDIX H

TABLE 4 (Continued)

Common Name (Scientific Name)	Colstrip	Special Concern	Skaar
Yellow-breasted chat (Icteria virens)			X
American redstart (Setophaga ruticilla)	X		X
House sparrow (Passer domesticus)	X		X
Bobolink (Dolichonyx oryzivorus)		X	
Western meadowlark (Sturnella neglecta)	X		X
Yellow-headed blackbird (Xanthocephalus xanthocephalus)	X		X
Red-winged blackbird (Agelaius phoeniceus)	X		X
Northern oriole (Icterus galbula)	X		X
Brewer's blackbird (Euphagus cyanocephalus)	X		X
Common grackle (Quiscalis quiscula)	X		X
Brown-headed cowbird (Molothrus ater)	X		X
Western tanager (Piranga ludoviciana)	X		X
Black-headed grosbeak (Pheucticus melanocephalus)			X
Lazuli bunting (Passerina amoena)			X
Dickcissel (Spiza americana)		X	X
Evening grosbeak (Hesperiphona vespertina)	X		X
Cassin's finch (Carpodacus cassinii)			?
Gray-crowned rosy finch (Leucosticte tephrocotis)	X		X
Black rosy finch (Leucosticte atrata)			X
Pine siskin (Spinus pinus)	X		X
American goldfinch (Spinus tristis)	X		X
Red crossbill (Loxia curvirostra)	X		X
Rufous-sided towhee (Pipilo erythrophthalmus)	X		X
Lark bunting (Calamospiza melanocorys)	X		X
Savannah sparrow (Passerculus sandwichensis)	X		X
Grasshopper sparrow (Ammodramus savannarum)	X		X
Baird's sparrow (Ammodramus bairdii)			
Vesper sparrow (Pooecetes gramineus)	X		X
Lark sparrow (Chondestes grammacus)	X		X
Dark-eyed junco (Junco hyemalis)	X		X
Tree sparrow (Spizella arborea)			X
Chipping sparrow (Spizella passerina)	X		X
Clay-colored sparrow (Spizella pallida)			X
Brewer's sparrow (Spizella breweri)		X	X
Harris' sparrow (Zonotrichia querula)			X
White-crowned sparrow (Zonotrichia leucophrys)	X		X
Lincoln's sparrow (Melospiza lincolnii)			X
Song sparrow (Melospiza melodia)	X		X
Snow bunting (Plectrophenax nivalis)	X		X
McCown's longspur (Rhynocophanes mccownii)	X		X
Chestnut-collared longspur (Calcarius ornatus)			X

APPENDIX H

TABLE 5

REPTILES AND AMPHIBIANS EXPECTED IN SOUTHEASTERN MONTANA*

Common Name (Scientific Name)	Colstrip[1]	Special Concern[2]	Thompson[3]
Tiger salamander (Ambystoma tigrinum)	X		X
Plains spadefoot (Scaphiopus bombifrons)			X
Western toad (Bufo boreas)			?
Rocky Mountain toad (Bufo woodhousei)			X
Great Plains toad (Bufo cognatus)			X
Dakota toad (Bufo hemiophrys)			X
Boreal chorus frog (Pseudacris triseriata)			?
Leopard frog (Rana pipiens)	X		X
Bullfrog (Rana catesbiana)			X
Snapping turtle (Chelydra serpentina)	X	X	X
Painted turtle (Chrysemys picta)	X		X
Spiny softshell (Trionyx spiniferus)		X	X
Sagebrush lizard (Sceloporus graciosus)	X		X
Eastern short-horned lizard (Phrynosoma douglassi)			X
Plains hognose snake (Heterodon nasicus)	X	X	X
Yellow-bellied racer (Coluber constrictor)	X		X
Bull snake (Pituophis melanoleucus)	X		X
Milk snake (Lampropeltis triangulum)			X
Common garter snake (Thamnophis sirtalis)	X		X
Plains garter snake (Thamnophis radix)			
Wandering garter snake (Thamnophis elegans)			X
Prairie rattlesnake (Crotalus viridis)	X		X

* Information from Stebbens (1966) maps and text.

1 Denotes species seen in the Rosebud Mine Wildlife Studies.

2 Denotes species listed by Flath, 1981.

3 Denotes species listed from latilong 33 or 43 by Thompson, 1981.

APPENDIX I

TABLE 1

PERSONAL INCOME, BY MAJOR SOURCE
ROSEBUD COUNTY AND MONTANA, 1970 and 1979
(In Thousands of 1980 Dollars)

	Rosebud County				Montana			
	1970		1979		1970		1979	
	1980 Dollars	Percentage of Total	1980 Dollars	Percentage of Total	1980 Dollars	Percentage of Total	1980 Dollars	Percentage of Total
Total Personal Income	$33,201	100.0	$67,282	100.0	$ 4,697,355	100.0	$ 6,787,331	100.0
Labor and Proprietors' income	26,181	78.9	56,412	83.9	3,661,398	77.9	4,930,531	72.7
Farm	6,221	18.7	1,830	2.7	533,570	11.4	326,483	4.8
Agricultural services, other	306	.9	301	.5	13,011	.3	23,148	.4
Mining	1,286	3.9	14,085	20.9	125,642	2.7	208,172	3.1
Construction	710	2.1	7,301	10.9	256,081	5.5	408,330	6.0
Manufacturing	2,177	6.6	2,421	3.6	397,178	8.5	537,739	7.9
Transportation, Public Utilities	3,528	10.6	6,124	9.1	335,892	7.2	548,160	8.1
Trade	2,564	7.7	4,066	6.1	626,110	13.3	903,224	13.3
Finance, insurance, and real estate	278	.8	896	1.3	136,134	2.9	238,870	3.5
Services	4,086	12.3	10,598	15.8	482,594	10.3	774,948	11.4
Federal government	1,929	5.8	2,752	4.1	305,926	6.5	341,728	5.0
State and local government	3,096	9.3	6,038	9.0	449,260	9.6	619,729	9.1
Dividends, interest, and rents	5,253	15.8	10,064	15.0	696,787	14.8	1,289,958	19.0
Transfer payments	4,332	13.1	7,353	10.9	519,436	11.1	889,869	13.1
Social security contributions and residence adjustments	-2,564	-7.7	-6,547	-9.7	-180,266	-3.8	-323,027	-4.8

Source: U.S. Bureau of Economic Analysis, 1981.

APPENDIX I

TABLE 2

PERSONAL INCOME BY BROAD CATEGORIES
ROSEBUD COUNTY, 1970 to 1979
(In Thousands of 1980 Dollars)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Total personal income	$33,201	$31,764	$36,698	$52,345	$51,750	$72,037	$63,611	$60,348	$71,642	$67,282
Labor and proprietors' income	26,181	25,228	30,823	46,055	44,893	70,453	61,614	53,086	62,269	56,412
Farm	6,221	4,128	6,609	13,955	6,983	2,587	-804	-701	6,820	1,830
Agricultural services, other	306	223	259	186	200	215	419	318	311	301
Mining	1,286	1,601	2,279	7,202	7,505	11,562	13,760	13,283	14,320	14,095
Construction	710	436	947	1,653	5,177	37,590	19,820	11,308	7,957	7,301
Manufacturing	2,177	2,395	2,389	1,871	1,909	1,675	1,271	752	1,385	2,421
Transportation, Public Utilities	3,528	3,380	3,850	4,157	4,401	4,223	4,975	5,435	5,439	6,124
Trade	2,564	2,697	3,025	3,280	3,484	4,191	4,117	3,619	3,717	4,066
Finance, insurance and real estate	278	355	480	513	564	544	827	846	859	896
Services	4,086	4,592	5,215	6,840	7,706	8,049	9,428	10,153	10,856	10,598
Federal government	1,929	2,161	2,343	2,439	2,672	3,049	2,501	2,634	2,744	2,752
State and local government	3,096	3,260	3,419	3,959	4,292	4,768	5,300	5,439	5,861	6,038
Dividends, interest, and rents	5,253	4,837	4,448	5,595	6,587	6,820	7,610	8,713	9,546	10,064
Transfer payments	4,332	4,477	4,515	5,050	5,449	6,173	7,010	7,100	7,119	7,353
Social security contributions and residence adjustments	-2,564	-2,758	-3,088	-4,355	-5,179	-10,409	-12,623	-8,551	-7,292	-6,547

Source: U.S. Bureau of Economic Analysis, 1981

APPENDIX I

TABLE 3

PER CAPITA PERSONAL INCOME
ROSEBUD COUNTY AND MONTANA, 1970 TO 1979
($1980)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Rosebud County	$5,493	$5,204	$5,217	$7,633	$6,613	$7,463	$6,434	$6,213	$7,555	$6,948
Montana	$6,803	$6,533	$7,257	$7,982	$7,776	$7,563	$7,745	$7,747	$8,503	$8,601
Percentage of Montana	80.8	79.7	78.8	95.6	85.1	98.7	83.1	80.2	88.9	80.8

Source: U.S. Bureau of Economic Analysis, 1981

APPENDIX I

TABLE 4

EMPLOYMENT, BY INDUSTRY,
ROSEBUD COUNTY AND MONTANA, 1970 and 1979

	Rosebud County			
	1970		1979	
	Number	Percentage of Total	Number	Percentage of Total
Total	2,465	100.0	4,472	100.0
Agriculture	704	28.3	587	13.1
Mining	43	1.7	434	9.7
Construction	29	1.2	282	6.3
Transportation, communication, and public utilities	184	7.5	369	8.3
Manufacturing	214	8.7	163	3.6
Trade	217	8.8	432	9.7
Finance, insurance, and real estate	19	.8	65	1.5
Services	391	15.9	1,051	23.5
Federal government	107	4.4	163	3.6
State and local government	330	13.4	557	12.5
Nonfarm proprietors	228	9.2	369	8.3
	Montana			
Total	279,091	100.0	373,409	100.0
Agriculture	39,882	14.3	35,017	9.4
Mining	6,547	2.4	7,737	2.1
Construction	11,180	4.0	15,608	4.2
Transportation, communication, and public utilities	17,308	6.2	23,265	4.9
Manufacturing	23,963	8.6	28,907	7.8
Trade	48,575	17.4	73,566	19.7
Finance, insurance, and real estate	7,832	2.8	13,261	3.6
Services	38,458	13.8	60,594	16.2
Federal government	18,253	6.6	23,696	6.4
State and local government	41,376	14.7	52,759	14.1
Nonfarm proprietors	25,717	9.2	38,999	10.5

Note: Details may not add due to rounding.

Source: Western Analysis, Inc., 1982

APPENDIX I

TABLE 5

EMPLOYMENT BY INDUSTRY,
ROSEBUD COUNTY, 1970 to 1979

	1970	1971	1972	1973	1974	1975	1976	1977[a]	1978[a]	1979[a]
Total Employment	2,405	2,709	2,871	3,235	3,600	4,977	4,415	4,088	4,263	4,472
Agriculture	704	710	696	681	692	658	610	562	534	587
Mining	43	79	104	269	283	392	416	365	372	434
Construction	29	25	39	76	180	1,354	656	345	267	282
TPUC	184	181	192	193	212	210	226	313	349	369
Manufacturing	214	230	265	192	180	160	185	86	124	163
Trade	217	242	268	312	347	412	425	367	400	432
FIRE	19	26	37	43	49	50	61	59	61	65
Services	391	520	570	727	827	809	905	1,002	1,108	1,051
Federal government	107	110	118	116	137	154	132	142	152	163
State and local government	330	353	367	393	419	441	455	480	530	557
Nonfarm proprietors	228	233	215	233	274	330	344	367	366	369
Unemployment rate	3.1	3.0	3.2	3.2	3.6	3.3	5.8	6.9	5.9	5.0

[a]Adjustments were made to REIS data for the years 1977 through 1979 to reflect employment figures supplied by Montana Power Company, Western Energy Company, Peabody Coal Company and Long Construction.

Source: U.S. Bureau of Economic Analysis, 1981
Montana Department of Labor and Industry
Western Analysis, Inc., 1982

APPENDIX I

TABLE 6

BASIC AND DERIVATIVE EMPLOYMENT
ROSEBUD COUNTY, 1970 and 1979

	1970	1979	Change 1970-1979
Basic industries	1,306	2,380	1,074
Agriculture	704	587	-117
Mining	43	434	391
Construction (part)	11	238	227
Manufacturing (part	201	145	-56
Trade (part) and tourism[1]	49	64	15
Transportation, public utilities and communications	109	312	203
Government (part)	41	63	22
Other basic industries	148	537	389
Derivative industries	1,159	2,092	933
Construction (part)	18	44	26
Manufacturing (part)	13	18	5
Trade (part)	179	386	207
Finance, insurance, and real estate	19	65	46
Services (part)	244	506	262
Government (part)	396	657	261
Other derivative industries	290	416	126

[1]Includes hotels and motels plus estimated retail trade employment serving nonresidents.

Source: Western Analysis, Inc., 1982

APPENDIX I

TABLE 7

PERCENT CHANGE IN POPULATION
COLSTRIP, MONTANA, ROSEBUD COUNTY, MONTANA, AND MONTANA
1970 - 1980

	1970 Population	1980 Population	Percent Change
Colstrip	250*	3,258*	1200
Rosebud County	6,032	11,379*	189
Montana	694,409	786,690	13

*estimated

Source: U.S. Bureau of the Census
Montana Department of Administration
Western Analysis, Inc., 1982

APPENDIX I

TABLE 8

POPULATION BY AGE AND SEX, ROSEBUD COUNTY AND COLSTRIP, MONTANA
1970 - 1980

	Colstrip, Montana						Rosebud County, Montana					
	Male		Female		Total		Male		Female		Total	
	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980
5	12	196	13	192	25	388	298	645	311	669	609	1,314
5-9	14	223	14	203	28	426	339	582	352	560	691	1,142
10-14	15	165	14	170	29	335	372	561	333	532	705	1,093
15-19	12	142	11	103	23	245	276	560	271	497	547	1,057
20-24	7	123	9	167	16	290	165	493	210	539	375	1,032
25-34	15	383	14	348	29	731	353	1,022	342	1,005	695	2,027
35-44	14	245	14	187	28	432	337	699	309	564	646	1,263
45-54	14	121	13	103	27	224	346	821	307	456	653	977
55-64	11	95	10	51	21	146	261	453	236	349	497	802
65 +	12	26	12	15	24	41	304	300	310	372	614	672
Total	126	1,719	124	1,539	250	3,258	3,051	5,836	2,981	5,543	6,032	11,379

Source: U.S. Bureau of the Census
Western Analysis, Inc., 1982

APPENDIX I

TABLE 9

POPULATION BY AGE AS A PERCENT OF TOTAL POPULATION
COLSTRIP, MONTANA AND ROSEBUD COUNTY, MONTANA
1970 - 1980

	Percent of Total Population			
	Colstrip		Rosebud County	
Age	1970	1980	1970	1980
5	10.0	11.9	10.1	11.6
5-9	11.2	13.1	11.5	10.0
10-14	11.6	10.3	11.7	9.6
15-19	9.2	7.5	9.1	9.3
20-24	6.4	8.9	6.2	9.1
25-34	11.6	22.4	11.5	17.8
35-44	11.2	13.3	10.7	11.1
45-54	10.8	6.9	10.8	8.6
55-64	8.4	4.5	8.2	7.1
65 +	9.6	1.3	10.2	5.9

Source: U.S. Bureau of the Census.

APPENDIX I

TABLE 10

BASELINE EMPLOYMENT AND POPULATION FORECAST
ROSEBUD COUNTY AND COLSTRIP, 1980 - 2018

	1980	1981	1982	1983	1984	1985	1990	1995	2000	2010	2018
Agriculture	582	577	572	567	562	557	549	542	525	502	502
Mining	436	451	466	466	466	466	466	466	466	466	466
Construction	1,040	1,702	3,047	2,729	1,150	281	147	147	147	147	147
Manufacturing	145	185	193	195	198	200	212	222	233	249	249
TPUC	362	400	511	588	676	702	702	702	702	702	702
Trade	47	48	50	51	52	53	56	58	62	68	68
FIRE	0	0	0	0	0	0	0	0	0	0	0
Services	562	579	596	614	632	651	710	755	828	940	940
Government	64	64	84	101	85	67	70	70	70	70	70
Nonfarm Proprietors	10	11	11	11	11	12	13	13	14	16	16
Total Basic	3,248	4,017	5,530	5,322	3,832	2,989	2,925	2,975	3,047	3,160	3,160
Total Nonbasic	2,153	2,249	2,384	2,469	2,565	2,608	2,631	2,712	2,842	3,055	3,055
Total Employment	5,401	6,266	7,914	7,791	6,307	5,597	5,556	5,687	5,889	6,215	6,215
Rosebud Population	11,379	12,945	15,974	15,699	13,078	11,527	11,210	11,420	11,608	12,253	12,253
Net Migration	1,421	1,502	2,843	-504	-2,866	-1,548	-1,278	-311	-306	N/A	N/A
Colstrip Population	3,258	4,493	6,926	6,727	4,680	3,442	3,221	3,253	3,287	3,384	3,384

Source: Western Analysis, Inc., 1982

APPENDIX I

TABLE 11

BASELINE QUARTERLY EMPLOYMENT AND POPULATION FORECAST
ROSEBUD COUNTY AND COLSTRIP, 1982 - 1983

	1982				1983			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
Agriculture	574	573	571	570	569	568	566	565
Mining	466	466	466	466	466	466	466	466
Construction	2,389	2,910	3,418	3,470	3,347	3,121	2,495	1,954
Manufacturing	192	193	193	194	194	195	195	196
TPUC	470	510	526	539	549	576	610	615
Trades	50	50	50	50	51	51	51	51
FIRE	0	0	0	0	0	0	0	0
Services	589	594	598	603	607	612	616	621
Government	75	75	87	98	101	101	101	101
Nonfarm proprietors	11	11	11	11	11	11	11	11
Total Basic	4,816	5,382	5,920	6,001	5,895	5,701	5,111	4,580
Total Nonbasic	2,342	2,382	2,397	2,413	2,430	2,458	2,489	2,498
Total Employment	7,158	7,764	8,317	8,414	8,325	8,159	7,600	7,078
Rosebud Population	14,552	15,697	16,726	16,913	16,662	16,372	15,357	14,399
Colstrip Population	5,780	6,712	7,539	7,665	7,528	7,280	6,449	5,646

Source: Western Analysis, Inc., 1982

TABLE 12

Projections of Baseline Personal Income
Rosebud Count, Selected Years, 1980-2018
(In Thousands of 1980 Dollars)

	1980	1981	1982	1983	1984	1985	1990	1995	2000	2010	2018
Agriculture	4,610	4,780	4,955	5,138	5,327	5,522	6,448	7,070	7,628	9,022	9,022
Mining	12,842	13,044	12,987	12,918	13,583	14,048	16,556	19,519	28,323	42,330	42,330
Construction	24,295	39,918	72,056	66,403	28,862	8,015	4,836	5,391	6,023	7,472	7,472
Non-Agriculture	36,187	39,214	43,505	46,897	50,312	51,397	60,382	69,235	81,323	107,987	107,987
Property & Transfer	18,005	18,618	19,239	19,887	20,557	21,250	24,682	28,199	33,056	44,252	44,252
Social Insurance Contribution	-5,058	-6,292	-8,664	-8,525	-6,366	-5,126	-5,743	-6,467	-8,544	-11,076	-11,076
Total:	90,881	115,574	144,078	142,718	112,275	95,106	107,161	129,414	147,809	199,987	199,987
Population	11,379	12,945	15,974	15,699	13,078	11,527	11,210	11,420	11,608	12,253	12,253
Per Capita	7,986	8,928	9,019	9,090	8,585	8,250	9,559	11,332	12,733	16,321	16,321

Source: Bureau of Economic Analysis, U.S. Department of Commerce
Western Energy Company
Western Analysis, Inc.

APPENDIX I

TABLE 13

BASELINE PROJECTIONS OF HOUSING DEMAND IN
ROSEBUD COUNTY AND COLSTRIP

	Actual	Projected Housing									
	1980	1981	1982	1983	1984	1985	1990	1995	2000	2010	2018
Rosebud County											
Population	11,379	12,945	15,974	15,699	13,038	11,527	11,210	11,420	11,608	12,253	12,253
Households	3,764	4,415	5,624	5,534	4,530	3,952	4,062	4,326	4,534	4,882	4,882
Colstrip											
Population	3,258	4,493	6,926	6,727	4,680	3,442	3,221	3,253	3,287	3,384	3,384
Households	1,050	1,521	2,451	2,355	1,527	1,042	1,016	1,070	1,114	1,171	1,171

Source: U.S. Bureau of the Census
Sunlight Development Company
Western Analysis, Inc., 1982

APPENDIX I

TABLE 14

ROSEBUD COUNTY, COLSTRIP HIGH SCHOOL DISTRICT #19 AND COLSTRIP ELEMENTARY SCHOOL DISTRICT #19, SELECTED PUBLIC FINANCE DATA 1970 and 1980

	1970	1980
Rosebud County		
Total revenues	$2,636,911	$4,596,312
Total expenditures	2,204,047	4,255,762
Mill levies	48.33	25.16
Colstrip High School District #19		
Total expenditures	$177,024	$810,720
Total general fund budget	129,312	665,040
Mill levies	17.62	9.42
Colstrip Elementary School District #19		
Total expenditures	$89,089	$907,554
Total general fund budget	59,906	799,871
Mill leview	17.08	10.33

Source: Montana Superintendent's Office of Public Instruction.
Montana Taxpayers Association.
Rosebud County Annual Financial Reports.
Rosebud County Audit Reports.
Western Analysis, Inc., 1982

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TABLE 15

BASELINE PUBLIC FINANCE PROJECTIONS, ROSEBUD COUNTY, FY1981-2018
($1980)

Year	Total Expenditures	Operating Expenses	Operating Expenses/Capita	Total Revenues	Local Revenues	Property Taxes
1981[1]	$3,942,496	$3,198,206	$247	$5,084,336	$2,555,514	$1,585,875
1982	4,750,516	4,102,382	257	4,750,516	3,322,869	2,115,264
1983	4,935,613	4,299,451	274	4,935,613	3,532,543	2,334,545
1984	4,281,593	3,745,485	286	4,281,593	3,112,770	2,114,781
1985	3,901,887	3,425,709	297	3,901,887	2,871,682	1,992,055
1990	3,880,759	3,425,289	306	3,880,759	2,878,885	2,023,445
1995	3,918,076	3,489,456	306	3,918,076	2,897,434	2,025,968
2000	3,969,539	3,535,289	306	3,969,539	2,935,491	2,059,320
2005	4,069,721	3,624,512	306	4,069,721	3,009,576	2,115,735
2010	4,181,224	3,723,817	306	4,181,224	3,092,033	2,173,746
2015	4,041,587	3,599,456	306	4,041,587	2,988,771	2,069,254
2018	4,041,587	3,599,456	306	4,041,587	2,988,731	2,069,254

Mill Levies

1981[1]	15.46	1995	13.33
1982	21.89	2000	18.36
1983	19.87	2005	21.90
1984	14.03	2010	24.40
1985	11.40	2015	22.49
1990	11.39	2018	22.49

[1]1981 uses actual data and may not represent a balanced budget.

Source: Western Analysis, Inc., 1982

APPENDIX I

TABLE 16

BASELINE PUBLIC FINANCE PROJECTIONS, COLSTRIP HIGH SCHOOL DISTRICT #19, 1981-2018
($1980)

Year	Total Expenditures	Operating Expenses	Operating Expenses/Capita	Total Revenues	Local Property Taxes[1]	Mills[2]
1981[3]	$2,720,067	$2,423,750	$5,315	$2,607,378	$1,633,150	19.11
1982	3,887,458	3,736,615	5,315	3,887,458	2,401,655	25.77
1983	4,691,790	3,630,310	5,315	4,691,790	3,248,258	27.18
1984	3,565,004	2,524,740	5,315	3,565,004	2,561,083	18.48
1985	2,881,248	1,855,019	5,315	2,881,248	2,143,631	12.89
1990	2,746,986	1,738,084	5,315	2,746,986	2,055,866	15.16
1995	2,748,332	1,754,030	5,315	2,748,332	2,050,871	17.48
2000	2,719,931	1,775,291	5,315	2,719,931	2,014,016	23.15
2005	1,826,153	1,796,552	5,315	1,826,153	1,111,784	14.74
2010	1,853,167	1,823,128	5,315	1,853,167	1,128,230	16.14
2015	1,550,609	1,525,474	5,315	1,550,609	944,029	13.02
2018	1,550,609	1,525,474	5,315	1,550,609	944,029	13.02

[1]Property taxes generated from district mill levies only.
[2]Mill rates for district levied taxes only (e.g., General Fund, Transportation Fund, Bus Reserve Fund, Comp. Insurance Fund, and Adult Education Fund).
[3]1981 is actual data and may not represent a balanced budget.

Source: Western Analysis, Inc., 1982

APPENDIX I

TABLE 17

BASELINE PUBLIC FINANCE PROJECTIONS, COLSTRIP ELEMENTARY SCHOOL DISTRICT #19, 1981-2018
($1980)

Year	Total Expenditures	Operating Expenses	Operating Expenses/Capita	Total Revenues	Local Property Taxes[1]	Mills[2]
1981[3]	$3,876,011	$2,972,071	$3,412	$3,780,895	$2,635,917	30.25
1982	5,456,974	4,741,567	3,531	5,456,974	3,628,452	39.91
1983	5,574,639	4,768,202	3,657	5,574,639	3,735,732	34.71
1984	4,200,948	3,438,261	3,791	4,200,948	2,921,893	23.42
1985	3,018,641	2,291,300	3,435	3,018,641	2,078,035	13.87
1990	2,744,094	2,143,585	3,435	2,744,094	1,864,127	15.26
1995	2,663,348	2,167,632	3,435	2,663,348	1,773,509	16.79
2000	2,509,176	2,188,243	3,435	2,509,176	1,610,876	20.56
2005	2,257,227	2,222,596	3,435	2,257,227	1,344,825	19.80
2010	2,288,625	2,253,512	3,435	2,288,625	1,363,531	21.66
2015	1,911,839	1,882,507	3,435	1,911,839	1,139,048	17.45
2018	1,911,839	1,882,507	3,435	1,911,839	1,139,048	17.45

[1]Property taxes generated from district mill levies only.
[2]Mill rates for district levied taxes only (e.g., General Fund, Transportation Fund, Bus Reserve Fund, Debt Service Fund, Comp. Insurance Fund).
[3]1981 is actual data and may not represent a balanced budget.

Source: Western Analysis, Inc., 1982

APPENDIX I

TABLE 18

BASELINE PUBLIC FINANCE PROJECTIONS, COLSTRIP TOWNSITE, 1980-2018
($1980)

Year	Total Expenditures	Operating Expenses	Operating Expenses/Capita	Total Revenues	Local Revenues
1980[1]	$4,813,065	$ 701,250	$215	$5,223,915	$1,112,100
1981	2,167,249	1,061,249	236	2,580,281	1,474,281
1982	1,950,726	1,800,726	260	2,347,354	2,197,354
1983	2,230,903	1,930,903	287	2,373,842	2,073,842
1984	1,404,834	1,404,834	300	1,415,990	1,415,990
1985	1,033,214	1,033,214	300	1,041,419	1,041,419
1990	966,874	966,874	300	974,552	974,552
1995	976,480	976,480	300	984,234	984,234
2000	986,686	986,686	300	994,521	994,521
2005	1,001,095	1,001,095	300	1,009,044	1,009,044
2010	1,015,803	1,015,803	300	1,023,871	1,023,871
2015	848,303	848,303	300	855,041	855,041
2018	848,303	848,303	300	855,041	855,041

[1]1980 is actual data and may not represent a balanced budget.

Source: Sunlight Development Company.
Western Analysis, Inc., 1982

APPENDIX I

TABLE 19

PROJECTED POPULATION AND EMPLOYMENT IMPACT, AREA C EXPANSION, ROSEBUD COUNTY AND COLSTRIP
1982 - 2018

	1982	1983	1984	1985	1990	1995	2000	2010	2018
Mining	4	121	205	211	205	211	208	228	228
Construction	140	181	0	0	0	0	0	0	0
Total Basic	144	302	205	211	205	211	208	228	228
Total Nonbasic	2	75	127	132	129	135	136	153	153
Total Employment	146	377	332	343	334	346	344	381	381
Rosebud Population	271	720	646	664	632	653	637	706	706
Colstrip Population	224	532	432	441	422	436	410	469	469

Source: Western Analysis, Inc., 1982

APPENDIX I

TABLE 20

PROJECTED POPULATION AND EMPLOYMENT IMPACT, AREA C EXPANSION, ROSEBUD COUNTY AND COLSTRIP, 1982 - 1983

	1982				1983			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
Mining	2	4	4	6	6	120	161	197
Construction	12	57	144	347	204	368	128	25
Total Basic	14	61	148	353	210	488	289	222
Total Nonbasic	1	2	2	3	3	75	100	123
Total Employment	15	63	150	356	213	563	389	345
Rosebud Population	28	117	278	657	392	1,063	751	675
Colstrip Population	21	98	230	540	323	816	537	456

Source: Western Analysis, Inc., 1982

TABLE 21

Baseline and Impact Population
Comparisons - Rosebud County and Colstrip
1980 to 2018

	1980	1981	1982	1983	1984	1985	1990	1995	2000	2010	2018
Rosebud Baseline Population	11,379	12,945	15,974	15,699	13,078	11,527	11,210	11,420	11,608	12,253	12,253
Area C Impact Population	-0-	-0-	271	720	646	664	632	653	637	706	706
Total Population	11,379	12,945	16,245	16,419	13,724	12,191	11,842	12,073	12,245	12,959	12,959
Percent Change	0.0	0.0	1.7	4.6	4.9	5.8	5.6	5.7	5.5	5.8	5.8
Colstrip Baseline Population	3,258	4,493	6,926	6,727	4,680	3,442	3,221	3,253	3,287	3,384	3,384
Area C Impact Population	-0-	-0-	224	532	432	441	442	436	410	469	469
Total Population	3,258	4,493	7,150	7,259	5,112	3,883	3,643	3,689	3,697	3,853	3,853
Percent Change	0.0	0.0	3.2	7.9	9.2	12.8	13.1	13.4	12.5	13.9	13.9

Source: Western Analysis, Inc.

APPENDIX I

TABLE 22

PROJECTED PERSONAL INCOME TAX PAYMENTS TO MONTANA, AREA C EXPANSION, 1982-2018
($1980)

	1982	1983	1984	1985	1990	1995	2000	2010	2018
Total Earnings	$4,013,543	$8,372,084	$5,975,353	$6,360,577	$7,283,035	$8,796,060	$12,642,032	$20,710,608	$20,710,608
Income Tax	140,014	289,501	212,420	229,741	262,918	317,538	456,377	747,652	747,652
Area C Workforce	144	302	205	211	205	211	208	228	228

Source: Western Analysis, Inc., 1982

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TABLE 23

PROJECTIONS OF HOUSING DEMAND DUE TO AREA C EXPANSION, COLSTRIP, 1982- 2018

	1982			1983									
	2Q	3Q	4Q	1Q	2Q	3Q	1984	1985	1990	1995	2000	2010	2018
Baseline households	2,366	2,687	2,731	2,685	2,578	2,237	1,527	1,042	1,016	1,070	1,114	1,171	1,171
Impact population	98	230	540	323	816	537	432	441	422	436	410	469	469
Impact households	37	90	212	127	295	177	127	131	133	143	139	162	162

Source: U.S. Bureau of the Census
Sunlight Development Company
Western Analysis, Inc., 1982

APPENDIX I

TABLE 24

ACTUAL AND PROJECTED SCHOOL ENROLLMENTS DUE TO AREA C EXPANSION, COLSTRIP SCHOOL DISTRICT #19
1981-2000

	Total Enrollment			Area C Mine Increment (included in total)		
Year	Elementary (K-8)	High School (9-12)	Total	Elementary K-8)	High School (9-12)	Total
1981[1]	848	322	1,170	0	0	0
1982	1,218	491	1,709	40	16	56
1983	1,344	514	1,858	87	33	120
1984	997	402	1,399	97	39	136
1985	771	331	1,102	100	43	143
1990	749	322	1,071	97	42	139
1995	764	328	1,092	99	43	143
2000	777	333	1,110	101	43	144

[1]Actual

Source: Western Analysis, Inc., 1982

APPENDIX I

TABLE 25

ACTUAL AND PROJECTED FISCAL CONDITIONS DUE TO AREA C EXPANSION, ROSEBUD COUNTY, 1981-2018
(1980 Dollars)

Year	Total Expenditures	Operating Expenditures	Total Revenues	Local Revenues	Property Taxes[1]	Area C Property Taxes[2]	Mills
1981[3]	$3,942,496	$3,198,206	$5,084,336	$2,555,514	$1,585,875	$ 0	15.46
1982	4,830,285	4,171,980	4,830,285	3,378,417	2,150,325	0	21.54
1983	5,159,821	4,496,635	5,159,821	3,692,403	2,330,264	109,197	19.83
1984	4,490,850	3,930,497	4,490,850	3,264,292	2,028,970	188,037	13.46
1985	4,124,143	3,623,043	4,124,143	3,034,594	1,925,549	178,744	11.02
1990	4,097,591	3,618,401	4,097,591	3,039,234	1,938,945	196,620	10.91
1995	4,142,113	3,688,984	4,142,113	3,063,111	1,918,741	223,073	12.63
2000	4,201,124	3,741,540	4,201,124	3,106,749	1,915,212	257,115	17.07
2005	4,321,891	3,849,096	4,321,891	3,196,057	1,946,387	288,387	20.15
2010	4,446,090	3,959,707	4,446,090	3,287,903	1,994,747	304,249	22.39
2015	4,115,695	3,665,456	4,115,695	3,043,575	1,814,936	313,219	19.72
2018	4,115,695	3,775,456	4,115,695	2,817,260	1,969,909	313,219	19.72

[1]Property taxes collected on non-Area C taxable value from impact district mill levies.
[2]Property taxes collected on Area C coal production and equipment from impact district mill levies.
[3]1981 is actual data and may not represent a balanced budget scenario.

Source: Western Analysis, Inc., 1982

TABLE 26

Projected Increase in Taxable
Value in Rosebud County
Due to Area C Expansion
1983 - 2018 ($ 1980)

	Capital Investment Taxable Value	Gross Proceeds Taxable Value
1983	$4,729,809	$ 776,250
1984	4,412,140	9,557,100
1985	4,100,502	12,118,950
1990	2,824,599	15,195,600
1995	2,040,490	16,624,000
2000	1,480,954	13,579,200
2005	1,084,989	13,227,300
2010	795,641	12,792,600
2015	583,457	15,297,300
2018	583,457	15,297,300

Source: Western Energy Company
Western Analysis, Inc.

TABLE 27

Percentage Change in Rosebud County
Taxable Value Due to Area C
Expansion, 1981-2018 ($ 1980)

	Baseline Taxable Value	Impact Taxable Value	Percent Net Change
1981	$ 78,058,934	$ 78,058,934	0.0 %
1982	99,827,548	99,827,548	0.0
1983	117,499,048	123,005,107	4.69
1984	150,731,745	164,700,985	9.27
1985	174,726,388	190,945,840	9.28
1990	177,704,247	195,724,446	10.14
1995	151,939,673	169,604,163	11.63
2000	112,180,950	127,241,104	13.42
2005	96,596,749	110,909,038	14.82
2010	89,088,647	102,676,888	15.25
2015	92,020,587	107,901,344	17.26
2018	92,020,587	107,901,344	17.26

Source: Western Analysis, Inc.

TABLE 28

Net Effects of Area C Expansion
on Local Revenues and Operating
Expenditures, Rosebud County, 1981- 2018 ($ 1980)

	Net Change Operating Expenditures	Net Percent Change	Net Change Local Revenues	Net Percent Change
1981	$ -0-	0.0 %	$ -0-	0.0 %
1982	69,598	1.70	55,548	1.67
1983	197,184	4.59	159,860	4.53
1984	185,012	4.94	151,522	4.87
1985	197,334	5.76	162,912	5.67
1990	193,112	5.64	160,349	5.57
1995	199,528	5.72	165,677	5.72
2000	206,251	5.83	171,258	5.83
2005	224,584	6.20	186,481	6.20
2010	235,890	6.33	195,870	6.33
2015	66,000	1.83	54,804	1.83
2018	66,000	1.83	54,804	1.83

Source: Western Analysis, Inc.

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TABLE 29

ACTUAL AND PROJECTED FISCAL CONDITIONS DUE TO AREA C EXPANSION,
COLSTRIP HIGH SCHOOL DISTRICT #19, 1981- 2018
(1980 Dollars)

Year	Total Expenditures	Operating Expenditures	Total Revenues	Local Property Taxes[1]	Area C Property Taxes[2]	Mills[3]
1981[4]	$2,720,067	$2,423,750	$2,607,378	$1,633,150	$ 0	19.11
1982	4,011,722	3,858,865	4,011,722	2,477,309	0	26.59
1983	4,983,542	3,917,333	4,983,542	3,275,018	150,862	27.40
1984	3,802,728	2,758,610	3,802,728	2,458,000	247,812	17.74
1985	3,124,375	2,094,205	3,124,375	2,088,063	203,586	12.55
1990	2,979,307	1,966,639	2,979,307	1,939,613	257,693	14.30
1995	2,986,056	1,987,900	2,986,056	1,908,232	287,368	16.27
2000	2,941,447	1,993,215	2,941,447	1,831,826	317,051	21.05
2005	2,069,280	2,035,737	2,069,280	1,058,839	200,964	14.04
2010	1,860,100	1,829,948	1,860,100	948,155	184,296	13.56
2015	1,455,730	1,432,133	1,455,730	727,026	159,240	10.03
2018	1,455,730	1,432,133	1,455,730	727,026	159,240	10.03

[1]Property taxes collected on non-Area C taxable value from impact district mill levies.
[2]Property taxes collected on Area C coal production and equipment from impact district mill levies.
[3]Mill rates for district levied taxes only (re: Table 2.4.4-3).
[4]1981 is actual data and may not represent a balanced budget.

Source: Western Analysis, Inc., 1982

APPENDIX I

TABLE 30

ACTUAL AND PROJECTED FISCAL CONDITION DUE TO AREA C EXPANSION,
COLSTRIP ELEMENTARY SCHOOL #19, 1981-2018
(1980 Dollars)

Year	Total Expenditures	Operating Expenditures	Total Revenues	Local Property Taxes[1]	Area C Property Taxes[2]	Mills[3]
1981[4]	$3,876,011	$2,972,071	$3,780,895	$2,635,917	$ 0	30.25
1982	5,611,091	4,893,382	5,611,091	3,724,023	0	40.97
1983	5,956,782	5,144,831	5,956,782	3,779,291	193,333	35.11
1984	4,523,872	3,756,689	4,523,872	2,811,572	314,788	22.53
1985	3,318,674	2,586,730	3,318,674	2,036,306	220,484	13.59
1990	3,030,173	2,425,274	3,030,173	1,772,979	261,589	14.52
1995	2,956,403	2,456,191	2,956,403	1,668,988	279,119	15.80
2000	2,788,277	2,463,062	2,788,277	1,490,645	286,516	19.02
2005	2,553,771	2,514,590	2,553,771	1,256,636	264,866	18.51
2010	2,606,104	2,566,120	2,606,104	1,277,027	275,655	20.29
2015	2,037,436	2,006,177	2,037,436	976,384	237,493	14.95
2018	2,037,436	2,006,177	2,037,436	976,384	237,493	14.95

[1]Property taxes collected on non-Area C taxable value from impact district mill levies.
[2]Property taxes collected on Area C coal production and equipment from impact district mill levies.
[3]Mill rates for district levied taxes only (re: Table 2.4.4-3).
[4]1981 is actual data and may not represent a balanced budget.

Source: Western Analysis, Inc., 1982

APPENDIX I

TABLE 31

Actual and Projected Fiscal Condition Due to Area C Expansion
Colstrip Townsite, 1980- 2018
(1980 Dollars)

	Total Expenditures	Operating Expenses	Total Revenues	Local Revenues
1980[1]	$4,813,065	$ 701,250	$5,223,915	$1,112,100
1981	2,167,249	1,061,249	2,580,281	1,474,281
1982	2,008,965	1,858,965	2,418,421	2,268,421
1983	2,383,607	2,083,607	2,537,850	2,237,850
1984	1,534,511	1,534,511	1,546,697	1,546,697
1985	1,165,592	1,165,592	1,174,848	1,747,848
1990	1,093,549	1,093,549	1,102,233	1,102,233
1995	1,107,358	1,107,358	1,116,151	1,116,151
2000	1,109,759	1,109,759	1,118,572	1,118,572
2005	1,132,873	1,132,873	1,141,869	1,141,869
2010	1,156,586	1,156,586	1,165,771	1,165,771
2015	905,037	905,037	912,224	912,224
2018	905,037	905,037	912,224	912,224

[1]1980 is actual data.

Source: Western Analysis, Inc.

TABLE 32

Net Effects of Area C Expansion on
Local Revenues and Operating Expenditures
Colstrip Townsite, 1980-2018 ($ 1980)

	Net Change Operating Expenditures	Net Percent Change	Net Change Local Revenues	Net Percent Change
1980	$ -0-	0.0 %	$ -0-	0.0 %
1981	-0-	0.0	-0-	0.0
1982	58,239	3.23	71,067	3.23
1983	152,704	7.91	164,008	7.91
1984	129,677	9.23	130,707	9.23
1985	132,378	12.81	133,429	12.81
1990	126,675	13.10	127,681	13.10
1995	130,878	13.40	131,917	13.40
2000	123,073	12.47	124,051	12.47
2005	131,778	13.16	132,825	13.16
2010	140,783	13.86	141,900	13.86
2018	140,783	13.86	141,000	13.86

Source: Western Analysis, Inc.

TABLE 33

Montana Coal Severance Tax and
Federal Royalty Payments on Area C
Coal Production, 1983-2018 1980)

	Federal Royalties Payments	Montana Coal Severance Tax Payments
1983	$ 52,500	$ 517,500
1984	647,500	6,371,400
1985	822,500	8,079,300
1990	6,020,000	10,130,400
1995	6,180,000	10,416,000
2000	5,359,000	9,052,800
2005	5,226,750	8,818,200
2010	5,060,000	8,528,400
2015	6,003,000	10,198,200
2018	6,003,000	10,198,200

Source: Western Energy Company
Western Analysis, Inc.

APPENDIX M

TABLE 1

CULTURAL RESOURCE SURVEY SUMMARY

Date of Survey	Survey Organization	Survey Report Title (Report Date)	Portions of Area C, Block 1 Included in Survey	Portions of Buffer Zone Included in Survey
1971	University of Montana Statewide Archaeological Survey	1971 Archaeological Survey, Western Energy Co. Lands, Rosebud County MT (September 1972).	T1N, R41E, Sec. 7	T1N, R41E, Secs. 5, 6, 7, 8 T2N, R41E, SE1/4 Sec. 31
1973	Mineral Research Center Montana College of Mineral Science and Technology Foundation	Western Energy Co. Archaeological Investigations. Rosebud County, MT (1973).	T1N, R40E, Sec. 1-5, 11, 12	T1N, R41E, Sec. 17, 18 T1N, R40E, Sec. 1, 4, 5, 9-15 T2N, R40E, SE1/4, Sec. 36 T2N, R41E, NW, NE, SW1/4, Sec 31
1979	Cultural Resources Division Montana Tech Alumni Foundation Mineral Research Center	Reassessment of Cultural Resources on Western Energy Co. Area A. Rosebud County, MT (1979).	None	T2N, R41E, NW1/4, NW/NE1/4 and NE/SW1/4, Sec. 31
1979	Cultural Resources Division Montana Tech Alumni Foundation Mineral Research Center	Archaeology Report - Cultural Resources on Area B. Rosebud County, MT (1980).	T1N, R41E, E1/2/NE1/4/NE1/4 Sec. 7	T1N, R41E, Sec. 5, 6, 7, 8, 17, 18 T1N, R40E, Sec. 5, 9, 12, 13
May-June 1978 and May-June 1979	Cultural Resources Division Montana Tech Alumni Foundation Mineral Research Center	Cultural Resources Inventory and Assessment: Mining Area C Extension and One-Mile Buffer (1980).	T1N, R41E, Sec. 7	T2N, R40E, Sec. 31-36 T1N, R40E, Sec. 6, 7, E1/2, Sec. 8 T1N, R41E, Sec. 6, 7, 18 T2N, R41E, Sec. 31
1981	Cultural Resources Division Montana Tech Alumni Foundation Mineral Research Center	Report Not Yet Available	All of Area C, Block 1	All of buffer except T1N, R40E, Sec. 5-8, 17 and 18 T2N, R41E, Sec. 31 T2N, R40E, Sec. 6-8 and Sec. 31-36

APPENDIX M

TABLE 2

CULTURAL RESOURCES SUMMARY
AREA C, BLOCK I

Site Name	Site Number	Site Description	National Register Eligibility
Preshistoric:			
1. Cooley Site	24 RB 1059	Middle Archaic-Late Prehistoric Period temporary campsite.	Appears eligible. SHPO determination not yet made.
2. Medicine Root Site	24 RB 879	Late Plains Archaic occupation site with subsurface cultural deposits.	Additional testing recommended.
3. Fadhl Kill Site	24 RB 299	Late Prehistoric Period bison impoundment, kill, and processing site with subsurface cultural deposits. May also be a prehistoric occupation site.	Appears eligible. SHPO determination not yet made.
4. Tripoint Site	24 RB 873	Archaic-Late Prehistoic Period hunting lookout, lithic workshop, and temporary occupation site without subsurface cultural deposits.	Does not appear eligible. SHPO determination not yet made.
5. Farley Lookout Site	24 RB 1058	Hunting lookout and temporary campsite without subsurface cultural deposits.	Appears eligible. SHPO determination not yet made.
Historic:			
6. Fadhl Homestead	24 RB 884	Historic 1920s homestead complex including 13 standing wood frame structures.	Appears eligible. SHPO determination not yet made.

APPENDIX M

TABLE 2 (Continued)

Site Name	Site Number	Site Description	National Register Eligibility
Unknown:			
7. Three Ring Site	24 RR 1060	Three stone circles of unknown cultural or temporal affiliation.	Does not appear eligible. SHPO agrees.
8. Lynn's Square	24 RB 1071	Rectangular sandstone rock structure of unknown cultural or temporal affiliation.	Does not appear eligible. SHPO agrees.
9. Gene's Vision Quest	24 RB 1072	Two rock structures on knoll crests. The cultural or temporal affiliation is unknown.	Does not appear eligible. SHPO agrees.

APPENDIX M

TABLE 3

CULTURAL RESOURCES - SUMMARY
BUFFER ZONE

Site Name	Site Number	Site Description	National Register Eligibility
Prehistoric:			
1. McDonald Quarry Site	24 RB 303	Quarry site; stone procurement site	Does not appear eligible. SHPO agrees.
2. Rabbit Ridge Site	24 RB 310	Lithic scatter	Does not appear eligible. SHPO agrees.
3. Insite Site	24 RB 874	Lithic scatter/temporary occupation site with subsurface cultural deposits	Appears elgible. SHPO determination not yet made.
4. Wheatfield Vista Site	24 RB 876	Lithic scatter/temporary occupation site	Does not appear eligible. SHPO determination not yet made.
5. Forsite Site	24 RB 878	Lithic scatter/temporary occupation site within small rock shelter with sub-surface cultural deposits	Additional testing recommended.
6. Pottery Site	24 RB 1062	Lithic and ceramic scatter/ temporary occupation site	Does not appear eligible. SHPO determination not yet made.
7. Rocky Top Site	24 RB 1061	Lithic scatter/temporary occupation site	Does not appear eligible. SHPO agrees.
8. Sunburn Out Site	24 RB 881	Lithic scatter/lithic preparation, temporary occupation, and hunting lookout site with some subsurface cultural deposits	Does not appear eligible. SHPO determination not yet made.
9. Pigeon Site	24 RB 880	Lithic scatter	Does not appear eligible. SHPO determination not yet made.

APPENDIX M

TABLE 3 (Continued)

Site Name	Site Number	Site Description	National Register Eligibility
10. Dusty Shelter Site	24 RB 1069	Temporary occupation site within small rock shelter	Does not appear eligible. SHPO concurs.
11. Normand Estates Site	24 RB 883	Lithic scatter/temporary occupation and hunting lookout site	Does not appear eligible. SHPO determination not yet made.
12. East Fork Site	24 RB 886	Lithic scatter/possible camp or occupation site with subsurface cultural deposits	Additional testing recommended.
13. Albino Deer Site	24 RB 885	Lithic scatter/possible campsite with subsurface cultural deposits	Additiona testing recommended.
14. How Dry I Am Site	24 RB 252	Lithic scatter	Has been determined ineligible.
15. Sly Bison Site	24 RB 267	Bison kill site	Appears eligible. SHPO concurs.
16. ------	MAL 1401	Lithic scatter/may be a site	N/A
Historic:			
17. Castle Rock Post Office and Homestead Site	24 RB 335	1919 Homestead and site of first post office in the area	Does not appear eligible. SHPO concurs.
18. P.E. Davis Rock Art Site	24 RB 875	1892-1918 Historic rock art graffiti site	Does not appear eligible. SHPO determination not yet made.
19. Caskey 320 Site	24 RB 1067	Historic homestead site	Does not appear eligible. SHPO concurs.

APPENDIX M

TABLE 3 (Continued)

Site Name	Site Number	Site Description	National Register Eligibility
20. Doc Taylor's Place Site	24 RB 1065	1912 Homestead site	Does not appear eligible. SHPO disagrees.
21. Muskrat Homestead Site	24 RB 313	Historic homestead site	Does not appear eligible. SHPO disagrees.
22. Cooley Place	24 RB 1064	Historic homestead site near prehistoric Cooley Site	Appears eligible. SHPO determination not yet made.
Multi-Component:			
23. Lovelace Memorial Site	24 RB 301	Prehistoric and historic rock carvings	Does not appear eligible. SHPO agrees.
24. Petro City Site	24 RB 302	Prehistoric lithic scatter in association with prehistoric and historic petroglyphs	Does not appear eligible. SHPO agrees.
25. Connie's Gallery Site	24 RB 877	Prehistoric petroglyphs and historic rock art dating from 1876	Does not appear eligible. SHPO determination not yet made.

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